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NUTRITIONAL STUDIES WITH FRAGARIA II[1]

A STUDY OF THE EFFECT OF DEFICIENT AND EXCESS POTASSIUM, PHOSPHORUS, MAGNESIUM, CALCIUM, AND SULPHUR

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In Pamphlet No. 96 of the Dominion Department of Agriculture we reported on the effects of nitrogen, potassium, and phosphorous starvation in strawberry plants. It was shown that certain rather definite symptoms were exhibited by the plant in the absence of any one of these elements. Later, in the 1928 Report of this Division, we reported on a more complete series of experiments in which strawberry plants were subjected to certain periods of starvation for the elements referred to above. In this last report we were able to corroborate some of the points brought out in the earlier publication, particularly as regards foliage tints developed and the effect of phosphorus and potassium on set.

In this report we propose to deal more fully with the effects of the deficiency of the above elements, and, in addition, to discuss the effects of deficient magnesium, calcium, and sulphur, and the results obtained from an addition of an excess of any of the elements above mentioned.

Materials and Methods

METHODS EMPLOYED

One variety of strawberry was employed, namely, Parson Beauty. The plants were grown in the field from the time the young stolons rooted until the following spring, when they were lifted, graded as to size, and transplanted to six-inch pots. The medium used in the pots consisted of finely ground sandstone from the same quarry as reported in (*1*).

The experiment has been conducted with three separate batches of material in three separate years and the results reported below are based on observations spread over that time. In the case of foliage and growth characteristics we are able to present data from three seasons, whereas in the event of yield, data from two seasons only are presented, owing to losses by winter injury in 1929.

NUTRIENT TREATMENTS

Forty-six different treatments were given which may be divided into five main groups, viz.: the potassium group, the phosphorus group, the magnesium group, the calcium group, and the sulphur group. Each of these groups was divided into an excess section and a deficiency section. In the excess section there were four different series, each series receiving an increment of the element in question over that given to the previous series.

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TABLE 1.—PARTS PER MILLION OF ELEMENTS

Series	Mg	K	Ca	N	S	P	Cl	Total
1	14.1	49.7	97.3	240.9	18.6	26.1	187.3	634
2	14.1	99.4	97.3	240.9	18.6	26.1	187.3	683.7
3	14.1	149.0	97.3	240.9	18.6	26.1	187.3	733.3
4	14.1	198.8	97.3	241.3	18.6	26.1	187.3	783.5
5	14.1	248.5	97.3	241.1	18.6	26.1	187.3	833.0
6	14.1		97.3	240.9	18.6	26.1	172.1	569.1
7	28.2		194.6	481.8	37.3	52.0	324.2	1118.1
8	42.3		291.9	722.7	55.9	78.3	516.3	1707.4
9	56.4		389.2	963.6	74.4	104.0	688.4	2276.0
10	84.6		583.8	1445.4	111.6	156.0	1032.6	3414.0
11	14.1	49.7	97.3	240.9	18.6	52.0	187.3	659.9
12	14.1	49.7	97.3	240.9	18.6	78.0	187.3	685.9
13	14.1	49.7	97.3	240.9	18.6	104.0	187.3	711.9
14	14.1	49.7	97.3	240.9	18.6	130.0	187.3	737.9
15	14.1	49.7	97.3	240.9	18.6		187.3	607.9
16	28.2	99.4	194.7	481.8	37.2		374.5	1215.8
17	42.3	149.0	292.0	722.7	55.9		561.8	1823.7
18	56.4	198.6	389.3	963.6	74.5		749.1	2431.5
19	84.7	297.9	584.0	1445.4	111.7		1123.7	3647.4
20	28.2	49.7	97.3	240.9	18.6	26.1	187.3	648.1
21	42.3	49.7	97.3	241.0	18.6	26.1	187.3	662.3
22	56.4	49.7	97.3	241.0	18.6	26.1	187.3	676.4
23	70.5	49.7	97.3	241.8	18.6	26.1	187.3	691.3
24		49.7	97.3	240.9	18.6	26.1	146.2	578.8
25		99.4	194.6	481.8	37.2	52.2	292.0	1157.2
26		149.2	291.9	722.7	55.8	78.2	438.0	1735.8
27		199.8	389.2	963.6	74.4	104.3	584.0	2315.3
28		297.9	583.8	1445.4	114.5	156.5	877.2	3475.3
29	14.1	49.7	194.7	240.9	18.6	26.1	359.5	903.6
30	14.1	49.7	292.0	240.9	18.6	26.1	531.4	1172.8
31	14.1	49.7	389.3	240.9	18.6	26.1	703.5	1442.2
32	14.1	49.7	486.7	240.9	18.6	26.1	875.5	1711.6
33	14.1	49.7		240.9	18.6	26.1	15.2	364.6
34	28.2	99.4		481.8	37.2	52.2	30.4	729.2
35	42.3	149.2		722.7	55.9	78.2	45.6	1093.9
36	56.4	198.8		963.6	74.5	104.3	60.8	1458.4
37	84.7	298.3		1445.4	111.7	156.5	91.3	2187.9
38	14.1	49.7	97.7	240.9	37.7	26.1	145.6	611.8
39	14.1	49.7	97.7	240.9	57.8	26.1	103.4	589.7
40	14.1	49.7	97.7	240.9	75.9	26.1	61.2	565.6
41	14.1	49.7	97.7	240.9	94.9	26.1	19.1	542.5
42	14.1	49.7	97.7	240.9		26.1	187.3	615.8
43	28.2	99.4	194.7	481.8		52.2	374.5	1230.8
44	42.3	149.2	292.0	722.7		78.2	561.8	1846.2
45	56.4	198.8	389.3	963.6		104.3	749.1	2461.5
46	84.6	298.3	584.0	1445.4		156.5	1123.7	3692.5

Thus, in the excess potassium section the first series received twice the amount of potassium applied to the check. The second series received three times that given to the check, increasing to five times that given in the check or normal series. This same system was followed in each of the other excess sections.

In the deficiency sections the first series received all elements in normal application excepting the element in deficiency which was completely omitted. The second series received all elements at twice the normal concentration as the check, increasing in further series until the elements fed were given at six times the normal concentration with the deficient element entirely absent.

In 1929 and 1930 the parts per million fed to each series were as in Table 1, whereas in 1931 the p.p.m. were altered by tripling the amount of potassium in the normal or check solution; all other elements fed remained the same as in Table 1.

METHODS

(1) *Cultural.*—The pots employed were 6-inch ordinary clay pots. The treatments were all given out of doors and no attempt was made to prevent rain from getting access to the pots. The pots were all set out in a cold frame, each pot having a clay saucer under it. Several inches of space surrounded each pot and a foot or more was left between each series. To enable the moisture and root temperature to be more easily controlled, well washed river sand was placed between each pot.

(2) *Feeding.*—Feeding was not started until the plants had become established in the pots. The first feeding was given in late May at which time 200 cc. of the dilute solutions was fed to each pot. Thereafter feeding was conducted once a week at the same rate. Watering was carried out when necessary, the plants being watched carefully and an attempt being made to maintain uniform and optimum moisture conditions throughout. At no time in the experiment did the water supply become a limiting factor.

Nutrient Solutions.—The nutrients employed were Baker's C.P.; these were made into stock solutions and measured amounts, according to requirements, were used. The stock solutions were as follows:—

$MgSO_47H_2O$—110 g. in 2000 cc. (1 cc. contains 55 mg.)
KH_2PO_4—85 g. in 1700 cc. (1 cc. contains 50 mg.)
KCl—25 g. in 1000 cc. (1 cc. contains 25 mg.)
$CaCl_2$—240 g. in 4000 cc. (1 cc. contains 60 mg.)
$NHNO_3$—350 g. in 3500 cc. (1 cc. contains 100 mg.)
KNO_3—30 g. in 1000 cc. (1 cc. contains 30 mg.)
$MgNO_36H_2O$—35 g. in 1050 cc. (1 cc. contains 30 mg.)
$NH_4H_2PO_4$—30 g. in 1000 cc. (1 cc. contains 30 mg.)

The details of the solution for Series 1 will exemplify the method employed throughout.

Amount of stock solution in 5000 cc. water:—

$MgSO_47H_2O$	13 + cc.	$CaCl_2$	23 cc.
KH_2PO_4	12 "	NH_4NO_3	34 "
KCl	6 + "		

The details of the solution below will illustrate how the solution was prepared in the event of the complete withdrawal of an element, in this case potassium.

$MgSO_47H_2O$	13 + cc.	NH_4NO_3	33 cc.
$CaCl_2$	23 "	$NH_4H_2PO_4$	16 "

RESULTS

FOLIAGE AND GROWTH OBSERVATIONS

The notes which were taken on foliage and growth characteristics revealed certain symptoms which could be associated with the treatment given in the majority of cases. These will be presented under the group headings.

The complete nutrient group, represented by Series 1, displayed good vigour and good foliage colour throughout the summer of 1929 and did not reveal any very marked symptoms of a deficiency nature. In the 1930 experiment this series, although exhibiting good growth, showed in late August, 1930, some purpling of the older leaves and a slight tendency for some of the leaves to curl upwards. As this appeared less pronounced in series 2 and 3, it was considered that the normal solution was possibly a little low in potassium or phosphorus.

Group 2 (excess potassium) represented by Series 2, 3, 4 and 5, behaved much as Series 1, although Series 4 and 5 did show slightly darker foliage and gave a slightly more vigorous appearance. All series looked as if they were slightly deficient for either potassium or phosphorus, the foliage tints resembling to a certain degree those exhibited by both the low potassium and the low phosphorus groups. As will be noted later, the low calcium, low magnesium, and low sulphur groups had none of these purplish or reddish-purple tints, so that it was suspected that probably the plants were not able to get hold of sufficient potassium or phosphorus, although ample was being supplied in the rations. This point will be discussed later.

Group 3 (potash deficient) represented by Series 6, 7, 8, 9 and 10, showed marked symptoms as early as July 2, when the leaves of Series 6 were abnormally dull and dark in colour, lacking the lustre of a normal leaf. Series 7 to 10 inclusive, showed drooping foliage at this date, with the leaves curling upwards and inward and Series 10 much reduced in vigour and the leaf petioles decumbent. This condition became aggravated in all series of this group and by August 12th very definite wilting was noticeable in all series, increasing in intensity from Series 6 to 10. This was accompanied by a distinct purpling on the underside of the majority of the leaves. In Series 7–10 a mosaic-like mottling was observed on many leaves and a large number of newer leaves in all series of this group, showed a burning of the margins, which by early September had become very pronounced, resulting in the death of many leaves.

Group 4 (excess phosphorus) including Series 11 to 14:—By late June, while Series 11 and 12 displayed normal colour and vigour, Series 13 and 14 began to display some slight burning of the foliage and a slight reduction in vigour. By September the older leaves in all series were light red in colour and only Series 11 continued to display normal vigour and colour of younger leaves, the burning of the margin of leaves in all other series being marked.

Group 5 (phosphorus deficient) including Series 15 to 19:—All series in this group began to display poor vigour and very dull brownish-green foliage in early June. The older leaves turned to a bronzed red, leaves became reduced in size and bronzing of all leaves became noticeable. Many plants were dead by early August.

Group 6 (excess magnesium) containing Series 20 to 23:—All series in this group resembled the normal very much in vigour, but as the season advanced very slight signs of marginal scorch developed. One or two plants exhibited a slightly chlorotic condition which, as in all the others, was soon followed by scorch. By September the older leaves showed considerable purpling indicating, as in the normal, a lack of either potassium or phosphorus. This was a more outstanding symptom than the slight amount of scorch present.

Group 7 (magnesium deficient) containing Series 24 to 28:—As a group these series were for a long time each season, previous to the fruiting year, among the most vigorous looking plants. They displayed large leaves, with no trace of tints or scorch until late August, when characteristic patches of brown, mostly confined to the margins, developed. These brown blotches or patches frequently fell out, leaving a gap in the margin. The petioles were always longer than in the normal series.

Group 8 (excess calcium) containing Series 29 to 32:—This entire group displayed lack of vigour and dark, dull green foliage, followed by purpling of older leaves and a great deal of scorch and blotch. The leaves were smaller and more sessile, with shorter petioles. In many respects they resembled the low potassium series and also the low phosphorus series. In the higher numbered series distinct curling inwards and upwards was noticeable, with the underside reddish-purple.

Group 9 (deficient calcium) containing Series 33 to 37:—These series exhibited exceptional vigour, with large leaves, long petioles and no tints. It was not until early fall of each season that a certain amount of blotch, similar to that described under the magnesium deficient series, developed. From that date onward leaves appeared restricted in growth extension.

Group 10 (excess sulphur) containing Series 38 to 42:—This group displayed normal growth vigour and colour until mid-summer, at which time the older leaves began to exhibit marked reddish purpling of older leaves, this being more pronounced in the higher numbered series of the group; size of leaves somewhat reduced, with shortened petioles. All these series exhibited in varying degree a certain amount of phosphorus deficiency.

Group 11 (sulphur deficient) including Series 42 to 46:—This group in 1929 continued to display excellent vigour and colour throughout, being one of the most vigorous groups in the experiment, without any definite foliage tints. In 1930-31, while as a group the larger leaf and longer petiole, expressive of excellent vigour, was noticeable, they did exhibit, particularly in the higher numbered series, a slight amount of apex blistering, which did not appear until late summer. In Series 46 this became quite general by mid-September. While this was not noted in 1929, it may have been passed up, as it was the appearance of an entirely new symptom which could easily have been unobserved.

Since this apex blistering was present more in the higher series, that is in those series having all elements in greater concentration, it is doubtless associated with high nitrogen in the absence of sulphur. A very small amount of apex blistering has been noticed wherever a sufficient excess of nitrogen has been fed, but it was more severe in the absence of sulphur than in the absence of any other element. In the higher deficient potassium series this was not noticeable as apex blistering, but took the form of more aggravated leaf scorch.

WINTER HARDINESS, 1929

In the fall the potted plants were covered over with a mulch of straw, similar to that given plants in the field. As very few plants came through the winter alive the yield data are of little significance and are not reported for this year.

The winter injury data, however, offer one or two outstanding points of interest. All series in which potash, sulphur, magnesium or phosphorus was deficient killed almost 100%, the minus calcium series were less affected, and the excess sulphur series showed less injury than any, with the excess potassium series coming second.

The results on this point from the 1930 experiment are given in a little more detail in Table 2.

TABLE 2.—WINTER INJURY IN DIFFERENT GROUPS OF THE 1930 EXPERIMENT. NOTES TAKEN IN SPRING, 1931

Series	Percentage of plants killed	
1	0	
2	16	
3	9	Excess potassium group.
4	7	
5	40	
6	33	
7	93	
8	100	Deficient potassium group.
9	100	
10	100	
11	25	
12	40	Excess phosphorus group.
13	9	
14	70	
15	16	
16	45	
17	75	Deficient phosphorus group.
18	63	
19	used for analysis	
20	9	
21	14	Excess magnesium group.
22	20	
23	9	
24	30	
25	63	
26	100	Deficient magnesium group.
27	100	
28	100	
29	4	
30	6	Excess calcium group.
31	25	
32	12	
33	30	
34	30	
35	33	Deficient calcium group.
36	50	
37	100	
38	55	
39	18	Excess sulphur group.
40	33	
41	11	
42	33	
43	18	
44	36	Deficient sulphur group.
45	85	
46	75	

Aside from Series 1, the complete nutrient series, the amount of injury was quite marked, deficient potassium and deficient magnesium producing the most marked results. The excess sulphur group again showed a tendency toward less winter injury, along with excess calcium and excess potassium. As will be noted in some groups, as for instance the excess potassium and excess phosphorus groups, the figures are not consistent, whereas in the deficient potassium, deficient magnesium and deficient calcium groups, the injury increased very consistently with the increase in concentrations of the other elements. On the other hand, in the excess sulphur group the injury consistently decreased with the increments of sulphur. This is probably the only information of any possible value in these results, as it would be expected that large amounts of injury would result from the deficient potassium and magnesium groups, although the latter plants really entered the winter in apparently a fair condition, certainly much better than the low phosphorus plants which came through with less injury. The possibility of sulphur influencing the winter hardiness of strawberry plants will be further examined. In the meantime it can only be accepted as a possible function of sulphur.

YIELD DATA

It is not possible in a report of this length to present the tabulated yield data. It may be said that each pot was treated as a separate plot. The number of blossoms produced by each plant was recorded as well as the number of fruits actually matured. No attempt was made to weigh the crop as each weighing from individual plants would be subject to a great deal of error on account of the small number of fruits produced at each picking. The data have been handled statistically and analysis of variance made. The following remarks are based only on such statistical analysis, only significant differences being taken into consideration.

In the case of the number of blossoms produced there has not been any significant decrease in blossom production, due to excess potassium, until the parts per million of potassium fed were in excess of 248, after which there was a significant reduction in the number of blossoms formed. In 1929 and 1930 the withdrawal of potassium brought about an almost significant reduction in bloom, while in 1932 the reduction was greater than that due to the greatest excess of that element. In the presence of higher nitrogen the absence of potassium in 1932 reduced the yield to almost a negligible quantity, whilst in 1929 and 1930 it resulted in the death of most of the plants.

Excess Phosphorus Group.—There appears to be a very close relationship between phosphorus and potassium in influencing fruit bud formation. High phosphorus feeding in the presence of high potassium feeding appears to bring about increased yield but high phosphorus feeding in the presence of low potassium brings about reduced yield. This point is made clearer by reference to Figure 1. It will be noted that the curve drops rather sharply as the ratio of potassium to phosphorus increases. Since the yield curve is inverse to the curve presented here, the effect of the potassium phosphorus relationship in influencing yield, is quite apparent. It would seem that the relationship should be in the vicinity of 3 to 1; that is to say,

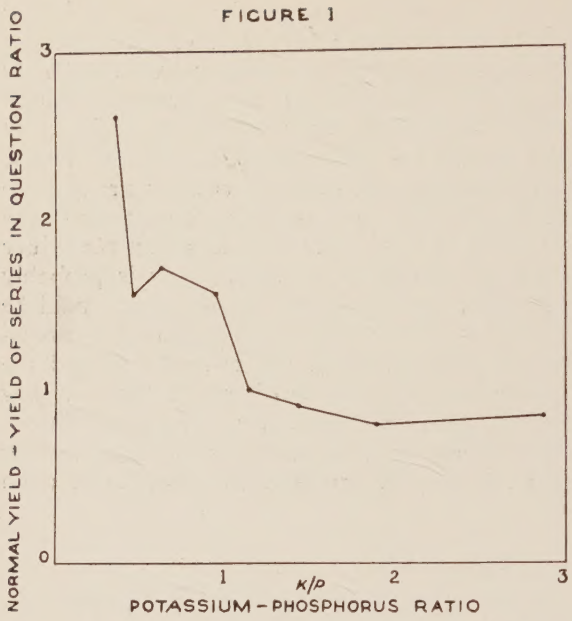

FIGURE 1. The effect of the Potassium-Phosphorus ratio in the nutrient solution in influencing yield.

the amount of potassium fed to the strawberry plant should be three times the amount of phosphorus to obtain maximum fruit bud formation.

In all experiments the withdrawal of phosphorus has caused a very marked reduction in fruit bud formation, much greater than the withdrawal of potassium. As in the case of the low potassium series, the reduction was greater in the presence of high nitrogen than in the presence of low nitrogen.

When excess magnesium was fed, significant differences were produced which would indicate the amount of magnesium fed should be from $\frac{1}{3}$ to $\frac{1}{4}$ the amount of potassium fed. Where the amount of magnesium fed was increased beyond $\frac{1}{3}$ that of the potassium fed, a marked reduction in yield took place.

The complete withdrawal of magnesium did not have as much effect on fruit bud formation as did the withdrawal of phosphorus or potassium, although a significant reduction took place. Unlike the minus phosphorus or potassium groups this reduction was not further increased by the presence of higher nitrogen.

The effect of excess calcium feeding on fruit bud formation was very marked when the amount of calcium fed was greater than three parts of calcium to one part of potassium fed. The withdrawal of calcium did not produce a significant effect on fruit bud formation until very large quantities of nitrogen were fed.

The excess feeding of sulphur did not significantly reduce the number of buds formed until 94 parts per million of sulphur were fed as in Series 41, when a significant reduction took place. The withdrawal of sulphur in the presence of a normal application of nitrogen did not bring about any reduction of yield but the complete withdrawal of sulphur in the presence of higher nitrogen brought about a very marked reduction in yield. There appears to be a very definite connection between sulphur and nitrogen which will bear further investigation.

In considering these data it must be remembered that where an element is said to be fed in excess we do not actually know that it was in excess; the term is but arbitrary. Whether or not it is in excess must be judged by the results obtained.

It would appear from a careful examination of blossoms, which indicates the number of fruit buds formed, that excess phosphorus feeding would probably be the most likely cause of trouble unless the available potassium was very high. The next most important point would likely be the high feeding of calcium and here again it appears to be a relationship with potassium. While it appears possible to reduce yield by excessive magnesium feeding, it is only when the concentration of that element has been raised to four times the normal that a significant reduction takes place.

In studying the effect of deficiency we should only deal with the first series of each group, for in the others the results may be due to toxicity of nitrogen or even of some other element. On this basis it is surprising that the potassium originally stored in the plant during its early days, has been able to maintain fruit bud production at such a high level, whilst the mere withdrawal of phosphorus has very markedly reduced fruit bud formation. It would appear that in so far as the actual formation of fruit buds is concerned there is little danger of over-feeding with potassium, magnesium or sulphur, but that excessive feeding of phosphorus or calcium is by no means a remote possibility in reducing the formation of fruit buds.

On the other hand there appears a marked ability on the part of the strawberry plant to utilize a small amount of stored potassium, so that if the plant is grown for a season under normal conditions and then subjected to low potassium conditions, the plant is able to cope with the situation to an almost efficient degree. This situation does not exist, however, with regard to deficient phosphorus or magnesium, which are soon reflected in reduced fruit bud formation, so that the danger of under-feeding of phosphorus or magnesium is of real importance. Low feeding of calcium or sulphur is not liable to be attended with any marked decrease in fruit bud formation.

CHEMICAL-CARBOHYDRATE ANALYSIS

Table 3 gives the result of analyses of the tops of certain series in terms of reducing sugars, sucrose, polysaccharides (as starch) and total nitrogen. The material for analysis was gathered in late October, the year previous to fruiting. Whilst there was considerable variation between some of the series, there are one or two points of outstanding significance. Thus, in the fact that the withdrawal of potassium resulted in a marked reduction in total carbohydrates. As the concentration of the other elements increased, or, in other words, as the ratio of potassium to other elements became wider, this reduction was more pronounced. This reduction appeared in reducing sugars, sucrose, and starch until only a trace of starch was found in Series 9. The addition of extra phosphorus has brought about a marked reduction in carbohydrates also, but just why Series 14 should show an increase over Series 11 is unexplainable at this stage, unless the slight difference existing is due entirely to error in sampling.

Deficient phosphorus has reduced carbohydrates about the same as deficient potassium and, as in deficient potassium, the decrease is more pronounced as the ratio of phosphorus to other elements becomes wider. It is also interesting to note that only a trace of starch was found in Series 18, as in Series 9, while the sucrose figure remained the same and did not, as in the comparable deficient potassium series, decrease.

TABLE 3.—ANALYSIS OF FOLIAGE (STEMS AND LEAVES)—MATERIAL GATHERED OCTOBER 14, 1930

Green weight	Dry weight	Percent dry weight	Dry matter basis					Nutrient solution	Series
			Reducing sugars	Sucrose	Poly-saccharides (as starch)	Total carbo-hydrates	Total nitrogen		
gms.	gms.	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.		
60.27	22.54	37.4	3.67	4.97	8.77	17.41	1.70	Complete	1
75.95	25.44	33.5	3.09	5.72	10.44	19.25	1.80	+ 2K	2
65.97	24.52	37.3	2.77	6.57	8.03	17.37	1.63	+ 4K	5
50.75	18.78	37.0	1.13	3.66	0.99	5.78	2.48	− K	6
29.74	9.64	32.4	0.35	1.97	trace	2.32	4.83	− K × 4	9
38.45	14.63	38.1	2.97	3.54	1.04	7.55	2.43	+ P	11
42.0	15.14	36.1	1.91	5.53	1.42	8.86	2.67	+ 4P	14
33.0	13.53	41.0	2.51	0.96	2.08	5.55	2.00	− P	15
28.0	12.11	43.2	1.93	0.99	trace	2.92	2.64	− P × 4	18
49.0	17.89	36.5	2.18	4.94	0.44	7.56	1.98	+ Mg	20
49.0	17.68	36.1	2.36	5.20	none	7.56	1.85	+ 4Mg	23
49.0	19.93	41.7	0.57	3.17	none	3.74	1.76	− Mg	24
40.0	13.97	34.9	trace	1.49	none	1.49	3.62	− Mg × 4	27
40.0	14.50	36.2	trace	0.59	0.88	1.47	2.22	+ Ca	29
40.0	14.87	37.2	0.27	0.43	none	0.70	2.43	+ 4Ca	32
40.0	15.08	37.7	0.13	1.07	0.35	1.55	2.02	− Ca	33
40.0	15.56	38.9	0.10	0.54	none	0.64	3.11	− Ca × 4	36
40.0	17.24	43.1	1.54	3.20	none	4.74	1.85	+ S	38
40.0	14.95	37.4	1.86	4.08	none	5.94	1.86	+ 4S	41
40.0	15.66	39.1	0.75	2.68	0.10	3.53	1.72	− S	42
40.0	14.03	35.1	0.34	0.83	0.48	1.65	2.96	− S × 4	45

Increased magnesium, while showing lower total carbohydrates, as compared to the normal, had about the same effect in this respect as increased phosphorus. The effect of increasing magnesium apparently is on the accumulation of starch, since only .44% was found in Series 20 and none in Series 23. Increasing magnesium resulted in a tendency to accumulate sucrose and reducing sugars at the expense of starch reduction.

Deficient magnesium has had a more marked effect on the reduction of total carbohydrates than deficient potassium, the decrease being very markedly progressive with the widening of the ratio of magnesium to other elements. This marked decrease, due to deficient magnesium, has been largely due to the elimination of starch.

Increasing calcium has had the most marked effect of reducing carbohydrates of any treatment given and this decrease becomes progressive as the calcium is increased.

Deficient calcium has likewise resulted in decreased carbohydrates, which becomes progressive as the ratio of calcium to other elements becomes greater.

Increasing sulphur has also resulted in carbohydrate reduction, but it is difficult to appreciate why a further increase in that element, as in Series 40, should show an increase as compared to Series 38.

Deficient sulphur shows a progressive reduction mainly at the expense of sucrose.

An examination of the data for total nitrogen would indicate that increasing the potassium, magnesium or sulphur beyond the amounts supplied in the normal solution has had little, if any, effect on the nitrogen accumulation in the plant. On the other hand, increasing the concentration of phosphorus shows a distinct tendency to increase the accumulation of nitrogen. Likewise increasing the concentration of calcium exhibits an equal tendency towards accumulation of nitrogen.

The omission of potassium, phosphorus and calcium have all resulted in an increase in nitrogen accumulation. On the other hand, the omission of sulphur or magnesium has not affected nitrogen accumulation.

In Series 9, 18, 27, 36 and 45 we have a group of series in which the nitrogen concentration of the feeding solution has been increased fourfold in the absence of one of the essential elements.

The maximum accumulation of nitrogen has taken place in the absence of potassium, with the absence of magnesium having the next most pronounced results. In the absence of phosphorus the increased additions of nitrogen to the ration has not added to the accumulation of nitrogen in the plant. This brings out an interesting situation. It has been shown elsewhere (*1*) that increases in nitrogen concentration, when accompanied by increases in mineral concentration, have resulted in more vigorous and more productive plants. In unpublished data in connection with tomatoes it has been found that excess nitrogen effects can be practically overcome by increasing the potassium ration, but that increasing the phosphorus ration fails to eliminate the excess nitrogen symptoms. In other words, it would appear that deficient potassium actually permits of a greater intake of nitrogen, and that deficient phosphorus has very little effect in that direction. Conversely, the evidence at hand would suggest that the presence of potassium tends to limit nitrogen intake, whilst phosphorus tends to augment it.

ASH ANALYSIS

In analyzing the ash of plant material in this project, generally recognized methods from various sources were combined to give what seemed to be a satisfactory procedure.

Table 4 gives the results from the analysis of leaves gathered in the Fall of 1931.

Table 4B gives the results of leaves gathered from a duplicate experiment in the Summer of 1931 after fruiting.

TABLE 4.—ANALYSES OF LEAVES GATHERED IN THE FALL OF 1931

Series	Treatment	Dry matter in fresh weight	Ash in dry matter	Ash constituents as % ash				
				CaO	MgO	K_2O	P_2O_5	SO_4
1	Normal	36.1	5.81	28.31	6.93	23.05	5.98	2.91
2	+K	35.5	6.79	27.09	5.9	30.27	6.28	2.46
3	+2K	35.6	7.49	24.47	5.64	30.99	5.79	2.50
4	+3K	35.8	6.64	17.42	5.20	37.01	6.18	3.51
5	+4K	34.3	6.50	21.78	5.28	37.65	5.38	2.68
6	−K	39.2	4.88	41.24	13.91	7.84	10.51	4.75
7	−K×2	35.6	4.84	33.70	14.61	10.78	16.60	5.97
8	−K×3	32.7	4.98	31.71	15.34	10.57	18.62	6.13
9	−K×4	34.7	5.23	28.18	14.32	13.56	15.16	5.16
10	−K×6	30.7	5.46	29.75	16.72	9.45	23.73	6.08
11	+P	36.6	6.29	32.29	8.71	20.16	8.64	2.93
12	+2P	36.2	4.96	33.97	8.46	19.25	9.54	2.49
13	+3P	36.3	6.37	28.56	8.25	21.51	9.34	2.92
14	+4P	37.1	6.06	32.60	8.44	21.27	11.60	2.87
15	−P	38.30	6.40	25.30	6.73	31.36	3.53	3.22
16	−P×2	41.50	6.42	23.27	5.62	34.74	3.53	3.04
17	−P×3	43.80	5.82	19.24	6.04	43.11	3.65	3.30
18	−P×4	40.80	6.36	20.14	6.22	39.05	3.78	3.18
19	−P×6	37.8	7.96	20.50	7.34	37.62	6.91	4.10
20	+Mg	36.9	6.01	31.66	9.08	26.17	7.51	3.51
21	+2Mg	35.6	8.51	27.57	9.71	22.70	6.75	2.81
24	−Mg	36.8	6.18	32.32	6.29	27.86	7.42	2.71
25	−Mg×2	35.4	6.43	32.76	5.81	28.14	7.92	2.46
26	−Mg×3	32.1	7.15	24.22	4.87	28.41	8.80	3.85
27	−Mg×4	29.9	7.43	26.53	5.16	27.06	10.37	4.54
28	−Mg×6	29.5	7.80	23.92	4.37	31.17	9.68	3.76
29	+Ca	37.7	6.41	32.93	7.24	24.33	7.34	2.68
30	+2Ca	37.6	6.25	34.18	6.74	23.58	6.57	2.68
31	+3Ca	35.1	6.21	36.57	6.67	23.88	7.00	2.51
32	+4Ca	34.7	7.08	33.81	6.32	22.96	6.37	2.77
33	−Ca	38.9	6.23	27.04	8.42	22.76	6.22	2.98
34	−Ca×2	35.6	6.02	24.38	9.52	29.45	8.45	3.92
35	−Ca×3	30.0	6.93	23.46	9.31	28.64	9.52	3.40
36	−Ca×4	32.8	6.76	17.86	9.0	34.68	11.06	4.66
37	−Ca×6	29.2	7.50	14.5	8.27	37.01	10.27	4.06
38	+S	34.9	6.77	26.1	8.06	25.09	6.77	2.89
39	+2S	37.3	6.22	31.91	7.35	26.81	6.65	3.0
40	+3S	38.2	6.28	29.35	8.10	26.28	7.21	2.81
41	+4S	37.3	6.37	26.80	8.29	25.58	6.63	3.44
42	−S	37.3	6.95	34.16	6.97	23.11	4.85	2.61
43	−S×2	32.9	6.95	26.19	6.30	26.79	7.70	3.05
44	−S×3	31.4	7.58	22.76	7.11	30.68	10.24	3.45
45	−S×4	30.6	7.98	24.16	6.37	28.18	10.16	3.42
46	−S×6	30.1	8.35	23.58	6.66	29.56	12.58	2.71

TABLE 4B.—ANALYSES OF LEAVES GATHERED FROM A DUPLICATE EXPERIMENT IN THE SUMMER OF 1931 AFTER FRUITING

Series	Treatment	Dry matter in fresh weight	Ash in dry matter	Ash constituents as % ash				
				CaO	MgO	K_2O	P_2O_5	SO_4
1	Normal	30.0	5.25	32.97	14.49	21.85	8.44	9.48
2	Normal + K	31.9	5.30	28.21	10.89	27.19	7.24	7.01
3	Normal + 2K	30.0	5.93	23.10	8.86	31.20	6.48	5.28
4	Normal + 3K	28.9	6.75	21.04	7.48	39.30	5.66	4.97
5	Normal + 4K	30.5	7.08	19.15	7.15	36.97	5.27	4.91
6	Normal − K	35.0	5.25	39.43	19.55	10.66	9.34	17.98
12	Normal + 2P	31.5	4.89	31.46	17.22	17.81	13.68	7.33
13	Normal + 3P	32.1	5.21	30.97	13.61	16.51	14.80	7.61
24	Normal − Mg	33.7	4.62	34.35	10.84	21.76	7.69	7.66
25	Normal − Mg × 2	37.4	5.46	30.92	10.77	23.55	10.00	9.93
29	Normal + Ca	35.0	6.27	31.60	11.10	12.37	6.73	6.18
31	Normal + 3Ca	31.4	6.13	38.11	9.85	17.70	7.99	7.50
32	Normal + 4Ca	32.7	6.29	38.13	9.20	15.05	7.50	4.93
33	Normal − Ca	35.0	4.73	22.63	13.41	23.80	8.22	7.32
34	Normal − Ca × 2	36.7	4.72	23.31	15.74	25.29	11.48	8.64
35	Normal − Ca × 3	35.8	4.79	20.63	16.11	26.57	14.38	8.39
36	Normal − Ca × 4	35.1	4.87	22.99	17.85	34.59	14.60	12.05
40	Normal + 3S	33.1	5.36	22.99	11.75	25.43	7.43	6.95
42	Normal − S	31.4	5.55	31.49	15.09	21.33	7.54	6.47

TABLE 5.—PER CENT OF EACH ELEMENT IN DRY MATTER SHOWN IN TABLE 4B, EXPRESSED IN TERMS OF PER CENT OF THE AMOUNT FOUND IN THE NORMAL SERIES

Series No.	Treatment	CaO	MgO	K_2O	P_2O_5	SO_4
1	Normal	100.0	100.0	100.0	100.0	100.0
2	Normal + K	86.1	75.0	148.7	86.7	74.5
3	Normal + 2K	79.2	68.4	160.7	86.7	62.8
4	Normal + 3K	82.1	65.8	257.3	86.0	67.2
5	Normal + 4K	78.6	65.8	226.9	83.7	69.8
6	Normal − K	115.6	132.9	48.1	109.5	187.5
12	Normal + 2P	88.4	110.5	75.6	150.3	71.8
13	Normal + 3P	93.1	92.1	74.7	173.8	79.5
24	Normal − Mg	91.9	65.8	87.9	79.9	71.1
25	Normal − Mg × 2	97.6	76.3	112.1	120.1	108.8
29	Normal + Ca	114.4	90.8	66.9	94.8	77.6
31	Normal + 3Ca	134.6	78.8	93.8	110.6	92.4
32	Normal + 4Ca	138.7	76.3	82.6	106.1	62.2
33	Normal − Ca	61.8	82.9	97.3	88.0	69.4
34	Normal − Ca × 2	63.6	97.3	103.4	122.3	81.9
35	Normal − Ca × 3	57.1	101.3	110.4	155.7	80.5
36	Normal − Ca × 4	64.7	114.4	146.1	160.3	117.8
40	Normal + 3S	71.1	82.9	118.2	88.0	74.9
42	Normal − S	101.1	110.5	102.6	94.3	72.1

Table 4 gives the results of the ash analysis of the leaves in terms of ash constituents and dry matter constituents.

Table 5 gives the results of the composition of dry matter of Table 4B expressed in per cent of the amount of the respective element found in the normal series. Plates 1 to 3 portray these results graphically. From an examination of these figures and tables, the following facts emerge; these will be discussed and interpreted later.

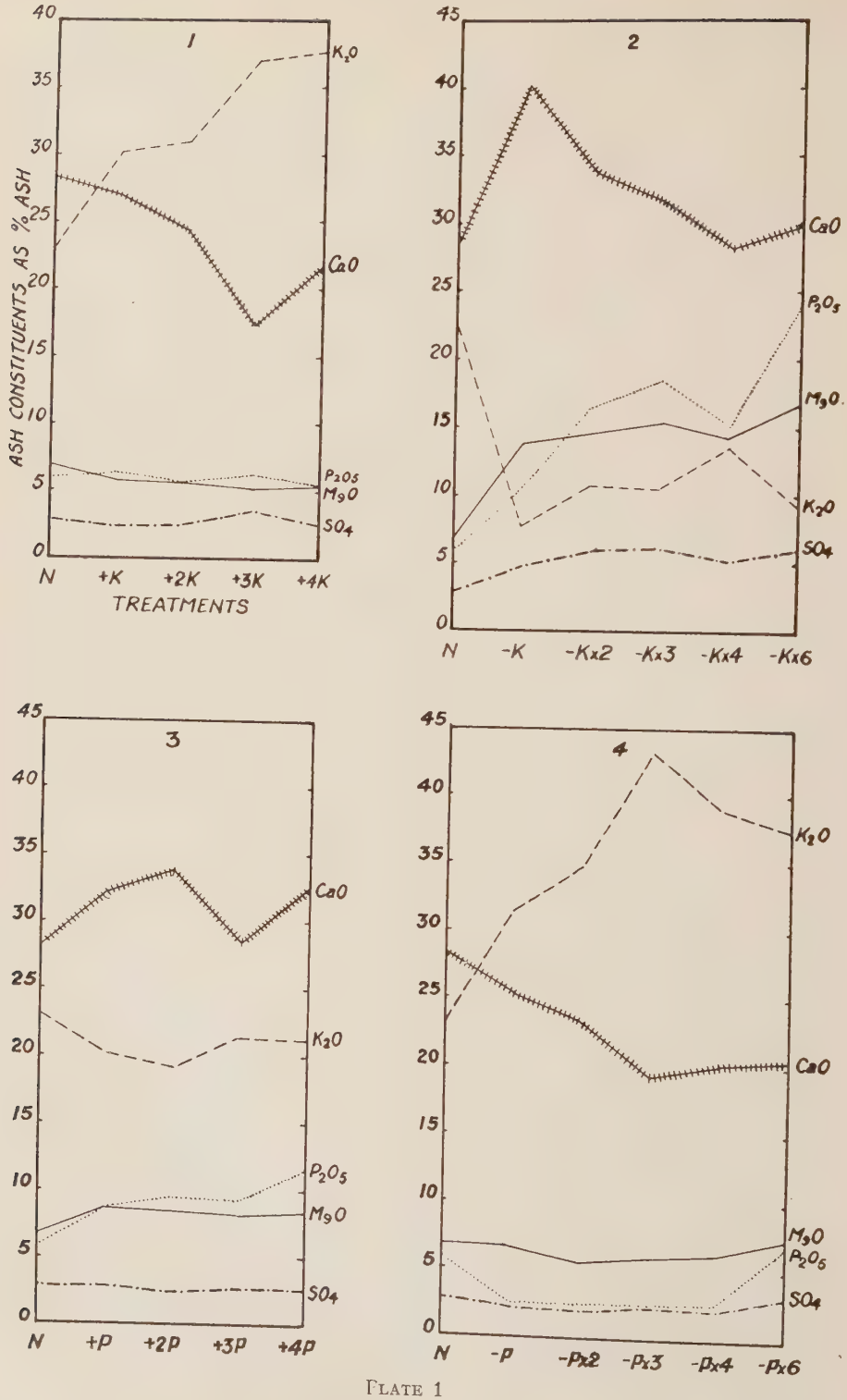
1
ASH CONSTITUENTS AS % ASH
K2O
CaO
P2O5
MgO
SO4
N +K +2K +3K +4K
TREATMENTS
2
CaO
P2O5
MgO
K2O
SO4
N -K -Kx2 -Kx3 -Kx4 -Kx6
3
CaO
K2O
P2O5
MgO
SO4
N +P +2P +3P +4P
4
K2O
CaO
MgO
P2O5
SO4
N -P -Px2 -Px3 -Px4 -Px6

PLATE 1

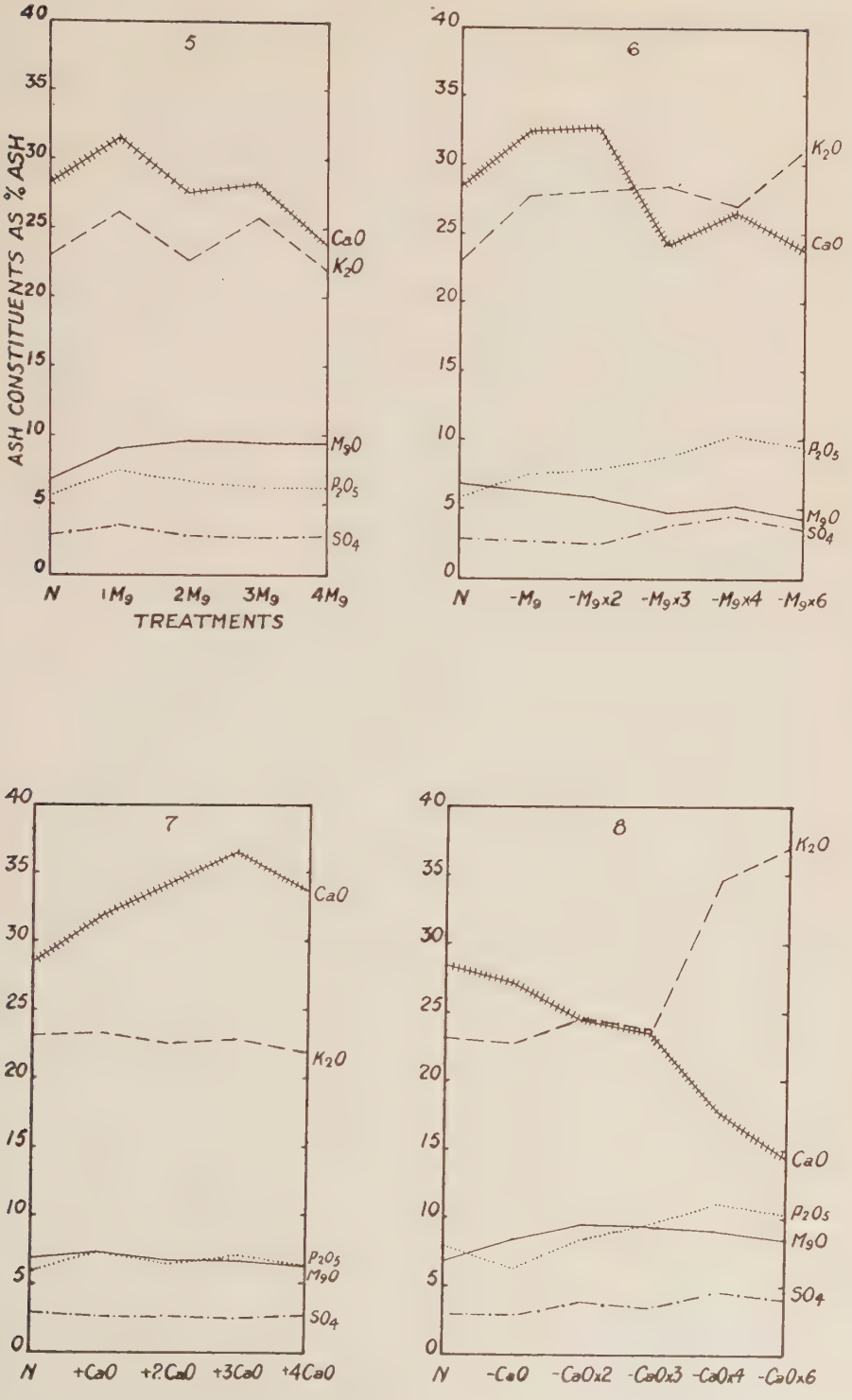
5
ASH CONSTITUENTS AS % ASH
CaO
K2O
MgO
P2O5
SO4
N
1Mg
2Mg
3Mg
4Mg
TREATMENTS
6
K2O
CaO
P2O5
MgO
SO4
N
-Mg
-Mg×2
-Mg×3
-Mg×4
-Mg×6
7
CaO
K2O
P2O5
MgO
SO4
N
+CaO
+2CaO
+3CaO
+4CaO
8
K2O
CaO
P2O5
MgO
SO4
N
-CaO
-CaO×2
-CaO×3
-CaO×4
-CaO×6

PLATE 2

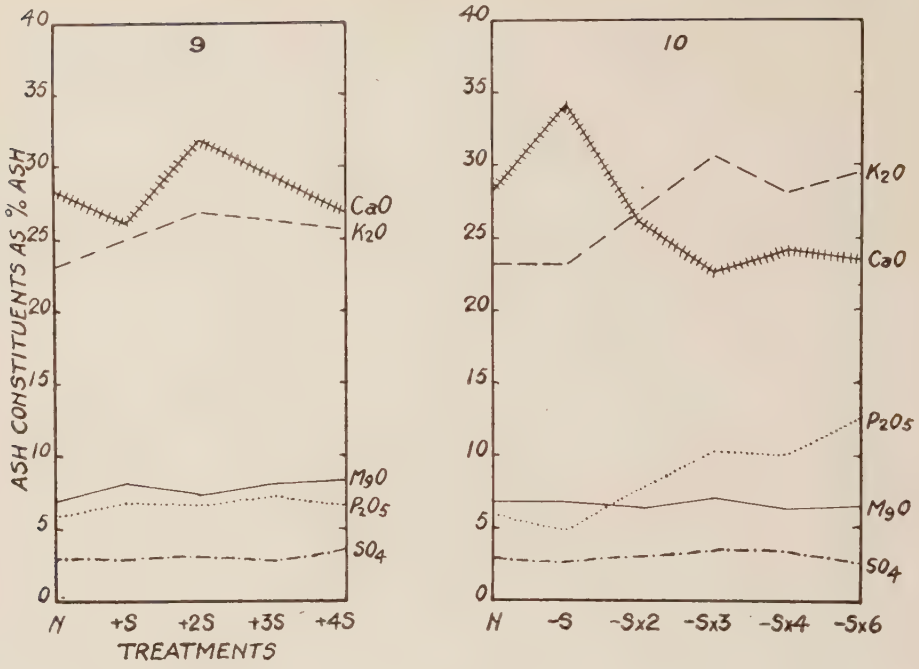

PLATE 3

The addition of potassium to the normal solution has resulted in a progressive increase in K_2O accumulation in both ash and dry matter. There has been an almost corresponding decrease in calcium in both ash and dry matter for both experiments; a reduced accumulation of magnesium in both experiments; no definite trend in P_2O_5 in Table 4 but a definite decrease in Table 4B and a decrease in sulphur accumulation in both experiments.

The withdrawal of potassium from the normal solution has resulted in a very marked decrease in K_2O in both ash and in dry matter, accompanied by a marked increase in CaO in ash and dry matter; a marked increase in MgO in both ash and dry matter, and an increase in P_2O_5 and SO_4 in both ash and dry matter.

Increased feeding of phosphorus has resulted in a marked increase of that element in both ash and dry matter; a decrease in the amount of K_2O in both ash and dry matter; an increase in calcium in both ash and dry matter in Table 4 only; and an increase in MgO in both ash and in dry matter. The further increments in phosphorus feeding have still further added to the increase of that element in both ash and in dry matter, with no definite trend in K_2O, CaO, MgO or SO_4 accumulation.

The complete withdrawal of phosphorus from the normal solution has resulted in a marked decrease of that element in both ash and in dry matter; a marked increase in K_2O in ash and in dry matter, a decrease in CaO in ash and in dry matter; no marked change in MgO or SO_4 until the nitrogen concentration becomes very high where an increase in MgO and SO_4 is observed, which is correlated with a marked increase in ash and in dry matter.

Increasing magnesium in the normal solution, as shown in Table 4, has resulted in increased MgO in both ash and dry matter; increased CaO and increased K_2O in both ash and in dry matter; and increased P_2O_5 and increased SO_4 in both ash and in dry matter. This analysis appears dubious as it is difficult to imagine an increase in the per cent of all bases.

The complete withdrawal of magnesium has resulted in a decrease in MgO in both ash and in dry matter; an increase in both CaO and K_2O in ash and in dry matter; and an increase in P_2O_5 in ash and in dry matter, with a decrease in SO_4 in both ash and in dry matter.

The further increase of the concentration of elements, other than magnesium, has resulted in a further decrease in MgO in ash and in dry matter; an increase in K_2O in ash and in dry matter; and a very marked increase in SO_4 and P_2O_5 in ash and in dry matter, with no further effect on CaO accumulation.

The feeding of excess calcium has resulted in a higher CaO figure in ash and in dry matter; little change in K_2O in ash in Table 4 but a drop in Table 4B; a lower figure for dry matter in both experiments; lower MgO in dry matter; lower SO_4 in ash and in dry matter; and higher P_2O_5 in ash and in dry matter in Table 4; but lower P_2O_5 in Table 4B, where the treatment has been prolonged. Further increments in calcium feeding have added further to the amounts of CaO in ash and in dry matter, with a reduction in MgO in ash and K_2O in ash but not in dry matter, due to higher figures for ash in dry matter. The figures for P_2O_5 and SO_4 have been little altered.

The complete withdrawal of calcium has not materially affected any figures except those for MgO in Table 4, where an increase of MgO in ash and in dry matter is recorded, but in Table 4B there has been an increase in K_2O with a decrease in CaO.

The further increase of the concentrations of elements, other than calcium, has given a much lower figure for CaO, accompanied by a very large increase in K_2O in ash and in dry matter; and an increase in MgO, SO_4 and P_2O_5 in ash and in dry matter.

The addition of excess sulphur to the normal in Table 4, has resulted in higher figures in ash and in dry matter for K_2O, MgO, P_2O_5 and SO_4, with a lower figure for CaO. Further additions of sulphur have not tended to bring about any further material alterations in the above relationship, except in higher values for MgO and SO_4.

The complete withdrawal of sulphur from the normal solution has resulted in a higher figure for CaO in ash and in dry matter and a lower figure for P_2O_5 in ash and in dry matter.

Further increases in the elements, other than sulphur, have resulted in a marked increase in K_2O and MgO in dry matter and a marked increase in P_2O_5 in both ash and in dry matter.

Discussion

From a consideration of the foregoing results, there are certain outstanding facts which are clearly evident and a few instances difficult to explain. In the first place, the antagonistic relation between Ca and K is fully apparent; as one falls the other tends to increase. This is more evident in the deficient groups than in the excess groups. Where potassium is

actually in excess it has certainly reduced CaO accumulation, but excess calcium has not always brought about a marked reduction in K_2O until prolonged subjection to this treatment. This antagonism or negative correlation between Ca and K has been reported by the senior author (*2*). The same relationship between K and Mg was also reported (*2*), but is more marked in these experiments with the strawberry. The outstanding relationship, which is somewhat different from that found in apples (*2*), is the relation existing between phosphorus and potassium. The complete withdrawal of potassium has resulted in a very marked increase in P_2O_5 accumulation, which is entirely opposite to that reported (*2*) and also opposite to that reported by Thomas (*3*). These results are more in accord with those reported by Lagatu and Maume wherein the omission of potassium from a fertilizer resulted in increased absorption of phosphorus.

Lagatu and Maume have advanced that their results are contradictory to Liebig's Law of the Minimum, which predicates decreased absorption of the remaining elements where one is present below the critical concentration. Thomas (*3*) has sought to show that in reality Lagatu and Maume's results are not actually contradictory and postulates that "the omission of an element already abundant in the soil from a fertilizer results in increased absorption by the plant of the remaining elements added in the fertilizer relative to the absorption of these elements from the complete fertilizer plot until the element omitted from the fertilizer becomes a limiting factor, *i.e.*, until its concentration is reduced below the limiting concentration."

In the results here reported, while we can only show the relative amounts of each element found in ash and in dry matter, the fact stands out that the complete withdrawal of potassium has certainly resulted in an increased amount of P_2O_5 found in the plant.

The other side of the story, namely, the addition of K, has evidently not tended to prevent or interfere with P_2O_5 accumulation until fed for a prolonged period as in Table 4B; conversely, increased phosphorus feeding has retarded potassium accumulation. Thus, excess P_2O_5 has at least tended to reduce the potassium found in the ash to a slight degree and the complete withdrawal of phosphorus has very markedly increased the amount of K_2O found.

On the limiting side these experiments deal only with the complete withdrawal of an element, or, in other words, something more than a deficiency, as they were designed primarily to obtain information of diagnostic value and extremes were sought for that purpose.

In Table 4A will be found the analyses from a different series of plants, in which potassium, phosphorus, calcium, magnesium and sulphur were merely deficient in the following way: take the two deficient phosphorus series; the one designated as 2 deficient P received all elements except P in twice a normal application, with P supplied in normal amount; 4 deficient P received all elements except P at four times normal strength and P in normal amounts; the same designations apply to the other deficient series.

An examination of this table reveals that deficient K has tended to increase P_2O_5 accumulation exactly as did its complete withdrawal; and that deficient phosphorus has resulted in a distinct tendency towards an increase in K_2O, as did its complete withdrawal.

TABLE 4A.—SHOWING ASH ANALYSES FROM A GROUP OF PLANTS IN WHICH THE ELEMENTS WERE MERELY DEFICIENT

Treatment	Series No.	CaO	K_2O	MgO	P_2O_5
		%	%	%	%
Normal × 2	1	29.40	20.22	8.72	13.34
2 Def. K	7	32.29	20.29	13.60	18.89
2 Def. P	16	23.80	23.84	7.33	8.80
4 Def. P	18	21.34	29.69	8.02	8.41
2 Def. Ca	34	26.78	22.69	10.99	14.08
4 Def. Ca	36	25.23	23.11	10.16	13.73
4 Def. Mg	27	23.85	28.43	6.03	16.48
4 Def. S	45	24.25	25.78	7.60	18.00

There would appear to exist in these experiments a negative relationship between P_2O_5 and K_2O, or, in other words, antagonism.

From the above facts, namely, that there exists a negative correlation between Ca and K and K and P_2O_5, we should expect a positive correlation to be found between P_2O_5 and Ca. This is partly evident in Table 4, where Ca and P have been completely withdrawn. We note that decreased accumulation of Ca results in the absence of phosphorus feeding and gets progressively less as the amount of Ca is increased in the feeding solutions, in the absence of phosphorus. In other words, when phosphorus is limiting the plant does not take up as liberal amounts of calcium. Increasing the P_2O_5 in the feeding solution has resulted in some increase in amount of CaO absorbed. On the other side, increased calcium feeding has resulted in slight increases in P_2O_5 in Table 4 but not in Table 4B where the high potassium concentration in the nutrient solution has tended to limit the P_2O_5 intake; but the withdrawal of calcium from the feeding solution has not, as we might expect, brought about a lower accumulation of P_2O_5 but rather an increase in the accumulation of that element.

Turning now to Table 4A we note confirmation of the fact that low or decreased Ca has resulted in increased P_2O_5, but that there is no increase in the P_2O_5 found in Series 16 over that of 18, where the amount of phosphorus fed was one-quarter that of the other.

There are certain outstanding points from the ash analyses which correlate to a degree with the foliage conditions and appearance of the plants.

In the first place the normal series exhibited signs of certain deficiencies which indicated either deficient phosphorus, potassium or both; secondly, the plants in the deficient calcium group and the deficient sulphur group were, during the major part of the season, free of any signs of deficient symptoms and exhibited the best vigour of any series until quite late in summer, when slight signs of calcium and sulphur deficiency were exhibited; and thirdly, the deficient magnesium group were almost as vigorous and were also free of deficient symptoms until quite late, when deficient magnesium symptoms were exhibited.

An examination of the data from these three groups of plants reveals certain things in common. Thus, they are all higher in potassium, excepting 33 and 42, which two series did not compare as favourably with the others of the groups. Again, they are all higher in P_2O_5 than the normal. We

have thus a high potassium and high phosphorus content, associated with increased vigour and lack of deficient symptoms for the major part of the season.

In other groups, such as the increased potassium group, we can associate the large amount of purpling with lower P_2O_5, and deficient potassium of the $-K$ groups with the burning and flagging of the foliage. In the excess phosphorus groups the low K_2O content may be associated with the scorch and lack of vigour of the plant. The low P_2O_5 content of the deficient phosphorus group is definitely associated with the bronzing and purpling of the foliage.

In the higher excess magnesium series the foliage scorch can be associated with a slightly lower K_2O content and the purple bronzing with the low P_2O_5, the same as in the normal series. The excess calcium group affords an opportunity for the raising of a pertinent question. In this group especially in the higher series, considerable scorch was observable in all experiments and would lead to the suspicion that low potassium was to be found. As the analyses reveal, however, the potassium is not lower in Table 3 than in the normal, but the calcium is higher. The scorch, therefore, is associated here with high calcium and a wide ratio between calcium and potassium.

An examination of the other groups reveals that this can also be said of them, namely, that the scorch condition of the low potassium series is associated with a high calcium content of the leaf. This is true in the low K group, and the high Ca group, where scorch was most noticeable. In a similar way the purplish colour of deficient phosphorus is associated in the groups with a low P_2O_5 content, such as in the normal, the higher potash group, the low P_2O_5 group, high magnesium group, the high Ca group and the high sulphur group. Conversely, the absence of these purplish and bronze tints may be associated with a high P_2O_5 content, as in the low K group, the high phosphorus group, the low magnesium group, the low calcium group and the low sulphur group. In other words, a fairly close association between symptomatic diagnosis and ash analysis is apparent, sufficient to warrant a further investigation along these same lines.

Correlations

Reference has already been made to apparent negative and positive correlations which exist in the amounts of certain elements found in the ash. The data under discussion have been arranged in the form of correlation tables and the result of this treatment is interesting.

These tables are not given but it may be pointed out that a very significant negative correlation between CaO and K_2O is found of $-.6724 \pm .049$. This is in full accord with Davis (*2*) and bears out the evidence submitted on this experiment so far.

The positive correlation of $+.5431 \pm .063$ between MgO and P_2O_5 is in accord with the small positive correlation found by Davis (*2*) which was not accepted as significant. In this case, however, a correlation of this magnitude can hardly be ignored.

The positive correlation of $+.3191 \pm .080$ between CaO and MgO is not in accord with Davis (*2*) where practically no correlation existed. It

might be well to bear in mind in this connection that in these experiments, while the complete withdrawal of certain elements was undertaken, as in Davis' work, there was, in addition, excess feeding of each element and in a few cases merely deficient feeding so that less extreme cases are included in the analyses.

The significant negative correlation between K_2O and MgO of $-.6893 \pm .047$ is very marked and is equal to that for K_2O and CaO.

The negative correlation already referred to between P_2O_5 and K_2O is fully borne out by the figure $-.4979 \pm .067$ and fully establishes that tendency in these experiments.

The positive correlation between CaO and P_2O_5, already mentioned as being expected or deducable from the established relationships between the other elements, is partially corroborated by the positive correlation of $+.1103 \pm .088$, although this figure is not fully significant.

We thus find the following significant negative correlations:—

K_2O and CaO $-.6724 \pm .049$
K_2O and MgO $-.6893 \pm .047$
K_2O and P_2O_5 $-.4979 \pm .067$

and the following significant positive correlations:

CaO amd MgO $+.3191 \pm .080$
MgO and P_2O_5 $+.5431 \pm .063$

and the doubtful positive correlation:

CaO and P_2O_5 of $+.1103 \pm .088$.

Since figures for nitrogen content are not available for all series it is not possible to correlate the amount of nitrogen found with the amounts of other elements. It is possible, however, to examine the correlations between the amount of nitrogen fed and the amount of any particular element found in ash. There are apparently significant positive correlations between nitrogen fed and the amount of potassium in ash and phosphorus in ash, and a positive correlation of doubtful significance between nitrogen fed and magnesium found. There is a highly significant negative correlation between the amount of nitrogen fed and calcium found. In other words, high nitrogen feeding tends to increased absorption of potassium and phosphorus and possibly magnesium and to decreased absorption of calcium.

Summary

1. Strawberry plants were grown in sterile sand in pots and subjected to the following nutrient treatments: complete nutrient, excessive potassium, deficient potassium, excess and deficient phosphorus, excess and deficient magnesium, excess and deficient calcium, and excess and deficient sulphur.

2. Foliage symptoms were obtained which could be correlated with the treatments given and which should prove of value in diagnosis.

3. Lack of hardiness during winter was associated more markedly with deficient potassium than with any other treatment.

4. Yield data indicate the possibility of reduced fruit bud formation due to excess phosphorus and excess calcium feeding.

5. The complete withdrawal of phosphorus and magnesium markedly affected fruit bud formation, while the complete withdrawal of calcium and sulphur had little, if any, affect.

6. The plants appeared capable of reutilizing their original potassium to a marked degree.

7. Carbohydrate analyses of the tops (leaves and crowns) indicated the marked influence of potassium in carbohydrate accumulation.

8. Ash analyses of the leaves revealed the marked influence on the composition of ash and dry matter of the various treatments.

9. All omission treatments were reflected by a reduction of the element concerned in ash and in dry matter.

10. Antagonism between calcium and potassium and phosphorus and potassium was revealed.

11. Lack of low potassium and low phosphorus symptoms of the foliage were noted in the series where calcium, magnesium or sulphur were not fed and this was associated with a high for those two elements found in ash and in dry matter.

12. Correlation figures are presented to show significant correlations as follows: a negative correlation between CaO and K_2O in ash; a positive correlation between MgO and P_2O_5; a negative correlation between K_2O and MgO, and a negative correlation between P_2O_5 and K_2O in ash.

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VARIATION OF SEX DIFFERENCE IN CHICK GROWTH

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As a general rule in work dealing with growth in poultry individual weekly weights are secured. This is usually the case whether the nutritional or genetic aspects of growth are under consideration. These figures are generally segregated and presented as weekly mean male and female weights, more often with, sometimes without indications of variability. Frequently such data are not further elaborated upon, while in other instances the male and female weights are again grouped together and either in tabular or graphic form presented as general averages. In still other cases the weights of one sex may be treated with one or another conversion factor in order to make them of comparable value to those of the opposite sex, whereafter they are considered as such. In this instance the object is either to give a general idea of growth in a particular breed or cross, to demonstrate the success or otherwise of a particular treatment, or it is frankly done so that paucity in numbers will not interfere with adequate statistical treatment of the data.

Schroeder and Lawrence (*4*) have determined the number of individuals necessary to secure even mathematical chances that a test may be duplicated with approximately the same results. This requirement presupposes a difference between the means of test and control lots of three times the standard error of the difference. However, in view of Fisher's (*1*) commonly adopted suggestion that adequate security is obtainable in this type of work with odds of 1 in 20, the numbers determined by the first mentioned authors become unnecessarily conservative for practical purposes. On the other hand, these authors state that the numbers required must be of one sex. Presumably this requirement must be understood as necessitated by the sex-different rate of growth and absolute growth, which in mixed populations would produce non-normal distributions, to which the ordinary tests of significance could not be applied.

It is the purpose of the present paper to demonstrate that the well known sex difference in growth in chickens, which, presumably, is regarded as a fairly stable phenomenon, in reality may be influenced to such extent by varying nutritional regimes that, in most instances, it will not be sound practice to treat male or female weights with conversion factors in order to facilitate their ultimate comparability.

Data

For the purpose of a nutritional experiment, to be later reported upon, 991 eggs were set from mature Barred Plymouth Rock females that had been mated to Single Comb White Leghorn males in flock matings. Hatchability proved to be 67.5% of the total eggs set, and the chicks were segregated according to sex by the method of Warren (*5*) at four periods during the actual hatch, which occurred during the twenty-four hours of the 20th day of incubation. From the two sex groups two pens were

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TABLE 1.—DIFFERENCES OF MEANS BETWEEN PENS AND SEXES AND THE STATISTICAL SIGNIFICANCE OF THESE DIFFERENCES, ALSO PER CENT RELATION OF MEANS

—	(1) Difference between means	(2) Probable occurrence of such difference by chance	(3) A weight as per cent of B weight	(4) Difference between means	(5) Probable occurrence of such difference by chance	(6) A weight as per cent of B weight
Weeks	A ♂ and B ♂			A ♀ and B ♀		
	Grams	%		Grams	%	
Initial 11/7	.112 ± .514	82.6	110.3	.100 ± .448	98.4	100.3
1st 18/7	2.388 ± 1.057	2.3	96.0	1.860 ± 1.021	6.9	103.4
2nd 25/7	.384 ± 2.191	85.7	99.6	3.764 ± 1.764	3.4	103.1
3rd 1/8	7.300 ± 3.304	2.7	94.9	2.60 ± 2.902	36.8	98.2
4th 8/8	6.180 ± 4.924	20.8	97.0	3.44 ± 4.089	40.1	101.7
5th 15/8	10.000 ± 6.379	11.7	96.7	2.28 ± 5.460	67.4	99.2
6th 22/8	15.23 ± 8.863	8.5	96.1	3.66 ± 6.779	58.9	99.0
7th 29/8	19.32 ± 10.857	7.5	96.2	4.12 ± 7.714	59.6	99.2
8th 5/9	27.76 ± 12.654	2.9	95.6	7.98 ± 8.813	36.3	98.6
	A ♂ and ♀		♀ weight as per cent of ♂ weight	B ♂ and ♀		♀ weight as per cent of ♂ weight
Initial 11/7	1.466 ± .537	0.64	96.0	1.454 ± .457	0.15	96.1
1st 18/7	.664 ± 1.068	53.5	98.8	4.192 ± 1.010	0.0046	91.7
2nd 25/7	2.688 ± 2.025	18.4	103.0	.460 ± 1.953	81.0	99.5
3rd 1/8	3.34 ± 3.141	28.9	102.5	1.36 ± 3.077	66.0	99.1
4th 8/8	7.34 ± 4.589	11.0	103.6	2.28 ± 4.463	61.0	98.9
5th 15/8	0.00 ± 5.792	100.0	100.0	7.72 ± 6.083	20.4	97.4
6th 22/8	1.35 ± 7.989	86.5	100.4	10.22 ± 7.789	19.1	97.4
7th 29/8	8.42 ± 9.168	35.8	98.3	23.62 ± 9.660	1.4	95.4
8th 5/9	21.36 ± 10.670	4.6	96.5	41.14 ± 11.213	.026	93.5

made up by random choice to contain 284 and 279 birds respectively. Each pen was distributed evenly over 16 compartments of a battery brooder, lots from the two pens alternating and care being taken that each lot contained approximately the same proportion of males to females. Both pens were fed the same all-mash ration. This ration is supposedly well balanced and well fortified with vitamins. The only difference in treatment of the two pens was, as far as we are aware, the extraction of certain presumably toxic elements from the feed of the pen designated "B", the "A" pen serving as normal control.

Mortality to eight weeks of age was fairly low amounting to 6.4 and 5.4% in the A and B pens respectively. As far as could be determined on macroscopic post mortem examination, no fatalities could be correlated to experimental treatment. Most of the deaths occurred during the first few days of the experiment or were due to smothering or in a few cases to cannibalism. A very few cases of "slipped tendon" occurred in each pen.

The chicks were weighed individually 50 to 70 hours after freedom from the shell had been gained, and subsequently every seventh day for eight weeks, nine weighings in all.

In statistical treatment of the data so obtained, it was found that pen A had an initial advantage over pen B of 1.47 grams, which proved to be a significant difference. Shortly, however this advantage disappeared, and by the end of the fifth week the relative positions of the two pens were significantly reversed. By the end of the eighth week the advantage

TABLE 2.—DIFFERENCES OF COEFFICIENTS OF VARIABILITY BETWEEN PENS AND SEXES AND THE STATISTICAL SIGNIFICANCE OF THESE DIFFERENCES

Weeks		(1) Difference between C.V.s	(2) Probable occurrence of such difference by chance		(3) Difference between C.V.s	(4) Probable occurrence of such difference by chance	
		A ♂ and ♀			B ♂ and ♀		
		%	%		%	%	
Initial	11/7	1.33 ± 0.986	17.7	♂ > ♀	0.43 ± 0.898	96.0	♂ > ♀
1st	18/7	1.52 ± 1.356	26.3	♂ < ♀	1.32 ± 1.264	29.8	♂ > ♀
2nd	25/7	1.70 ± 1.613	29.4	♂ > ♀	5.07 ± 1.554	0.118	♂ > ♀
3rd	1/8	0.07 ± 1.653	96.8	♂ > ♀	3.96 ± 1.560	1.09	♂ > ♀
4th	8/8	0.70 ± 1.613	66.7	♂ > ♀	5.17 ± 1.553	0.096	♂ > ♀
5th	15/8	1.61 ± 1.404	25.0	♂ > ♀	2.77 ± 1.476	6.0	♂ > ♀
6th	22/8	2.64 ± 1.506	8.0	♂ > ♀	4.46 ± 1.432	0.18	♂ > ♀
7th	29/8	3.29 ± 1.355	1.5	♂ > ♀	4.37 ± 1.386	0.16	♂ > ♀
8th	5/9	2.35 ± 1.290	6.9	♂ > ♀	4.64 ± 1.090	0.0034	♂ > ♀
		A and B ♂			A and B ♀		
Initial	11/7	0.144 ± 0.986	88.1	A > B	0.54 ± 0.899	54.9	A > B
1st	18/7	0.46 ± 1.302	72.6	A < B	2.38 ± 1.319	7.2	A > B
2nd	25/7	0.94 ± 1.757	58.9	A < B	2.43 ± 1.389	8.0	A > B
3rd	1/8	0.79 ± 1.714	64.6	A < B	3.10 ± 1.492	3.4	A > B
4th	8/8	1.29 ± 1.737	45.9	A < B	3.18 ± 1.415	2.4	A > B
5th	15/8	1.04 ± 1.558	50.3	A < B	0.12 ± 1.274	92.4	A > B
6th	22/8	0.04 ± 1.652	98.4	A > B	1.86 ± 1.260	13.9	A > B
7th	29/8	0.60 ± 1.567	70.4	A < B	0.48 ± 1.141	67.4	A > B
8th	5/9	0.96 ± 1.475	51.5	A < B	1.33 ± 1.178	25.8	A > B

of pen B over pen A had become so markedly significant that it was decided to carry as many pullets as possible of each pen over the full coming year.

As the distributions appeared to approach the normal and since the means were very significant the normal distribution curves were calculated on the two actually observed female curves. The X^2 test showed in both cases a marked goodness of fit, and a proportionate number of specimens were therefore chosen from each class of the normal distributions to make up 90 birds from pen A and 89 birds from Pen B. The records of the male populations were treated in a similar manner, and it is our belief that samples closely representative of the distribution of the full populations were secured by this treatment. All data presented in Tables 1 and 2 are taken from the records of the sample populations so chosen.

From the figures in Table 1 it may be seen that the A and B females practically had the same growth rate throughout, with a slight advantage for the A birds in the early stages, the relative positions being reversed in the later weeks (column 6). It may further be seen, that, of all the four sex-groups, the B males had the fastest growth throughout (column 3), whereas the A males grew at a similar rate to that of the A females with apparently even a slower growth rate up to the end of the sixth week (column 3).

Thus it is clear that on an analysis of the mean weights, the A males were quite adversely affected by the experimental treatment, while the females of this pen were affected very little. This was further brought out by correlation coefficients, showing relation in body weights of male

and female chicks at 50 to 70 hours after hatching to their body weight at 58 to 59 days of age.

CORRELATION COEFFICIENTS BETWEEN BODY WEIGHT AT HATCHING TIME AND EIGHT WEEKS OF AGE

	Pen A.	Pen B.
♂	$r = .10 \pm .087$	$r = .21 \pm .051$
♀	$r = .25 \pm .033$	$r = .21 \pm .049$

Although these coefficients are too low to be of practical value, still, with 128 or more degrees of freedom, they are highly significant with the one exception of the one for pen A males which shows no significance.

It would appear from the section of Table 2 showing relation in variability between the presumably normal males and females of pen B, that the variability of growth rate is much greater for the males than the females in this instance. In pen A there was very little to choose as to variability between males and females until six weeks of age at which time there was an indication of a significantly greater variability among the males. Although as previously noted (Table 1) the males of pen A suffered severely in body weight owing to the treatment accorded them they showed no significantly different variability than the males of pen B (Table 2). Conversely the females of pen A show, by this table, significantly greater variability than those of pen B in many instances although as noted their mean growth rate did not suffer from the treatment received.

Thus it is clear that in poultry the sexes respond in a different manner to adverse environmental conditions. In our experiment the males suffered a considerable mean retardation in growth while the treatment apparently affected the females only by increasing their variability. However, from the records published by Warren (*5*), Waters (*6*), Holmes, Pigott and Campbell (*2*), Roberts (*3*), and others, it would appear that this relationship may be reversed. In eight week old chicks "optimum growth" is in each case the response of the inherited rate of growth to whatever may be the most favourable environmental conditions for the particular breed or sex. Hence, it is obvious that results obtained on varying stock and under different environmental regimes will vary as any of several factors may favour or hamper one or the other sex as the case may be.

SUMMARY

1. The data herein reported would indicate that the normal sex difference in growth rate and absolute growth may be markedly influenced by environmental conditions.

2. It has been shown that in our control lot one sex was affected quite severely, while the opposite sex, subjected to identical treatment, was affected to a slight degree only if at all.

3. It is likewise apparent from our data that this sex-different response would have been lost sight of if the data had been treated as being from a

mixed population, and completely obscured if conversion factors had been used.

4. It has been found that a similar or reversed condition obtained in the data of other workers, and it is therefore concluded that mixed or converted growth data in fowls may be misleading, hence should not be used.

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YIELD AND QUALITY OF FRUIT FROM STRONGLY VEGETATIVE CONCORD GRAPE VINES

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In the spring of 1929 the Ontario Horticultural Experiment Station commenced a pruning and soil fertilization experiment at the Haines Concord vineyard situated about two miles east of Jordan. Plots are laid out on nine adjacent rows to make three series of three rows each, the series being pruned to 30, 36, and 42 buds. Each plot contains 18 vines, being three rows wide and six vines long. The vines are pruned to the 6-arm Kniffen system. While the soil[3] in this vineyard is quite variable, on the whole, grape growers would consider it a good grape soil of better than average fertility.

Every third plot in each series is a check plot on which no fertilizer of any kind has been applied since the experiment was started in 1929. It is with these untreated plots only that the present paper deals as a complete report on the experiment proper will appear at a later date. Such interesting relations between vigour of vine and yield and quality of fruit have shown up in these plots during the years 1932 and 1933 that an advance report on this particular phase would seem to be justified.

Samples for sugar and acid analysis were taken approximately two weeks before picking and again three days before picking each year. The mean of these two tests was taken as the sugar and acid content of the plot for that particular year. The berries were picked from the bunches, a uniform volume of fruit was squeezed in a Carver laboratory press at 4,000 lbs. pressure and the juice was immediately analyzed for sugar and total acid. Sugar determinations were made by a method given in Sutton's Volumetric Analysis, 10th ed., page 331, and the acid was obtained by the Official Method. Although the method used for sugar determinations includes other reducing substances than sugar the error introduced in giving the total reading as sugar is probably very small.

The data are given graphically in Figure 1. The 27 check plots have been divided into classes based upon their vigour of growth as represented by weight of prunings. Most of the differences in vine vigour have been due to varying soil conditions, but five years' moderately heavy pruning to a constant number of buds for a given series has tended to accentuate these differences. The graph figures show that the vines in the least vegetative plot have averaged 2.1 lb. of prunings per year while the vines in the most vegetative plot have produced an average of 4.6 lb. of prunings. Yield figures are the means per vine per year, and acid and sugar figures are the means per plot per year.

It is of special interest that the weakest growing plots have given grapes of the best quality as measured by sugar and acid in the juice,

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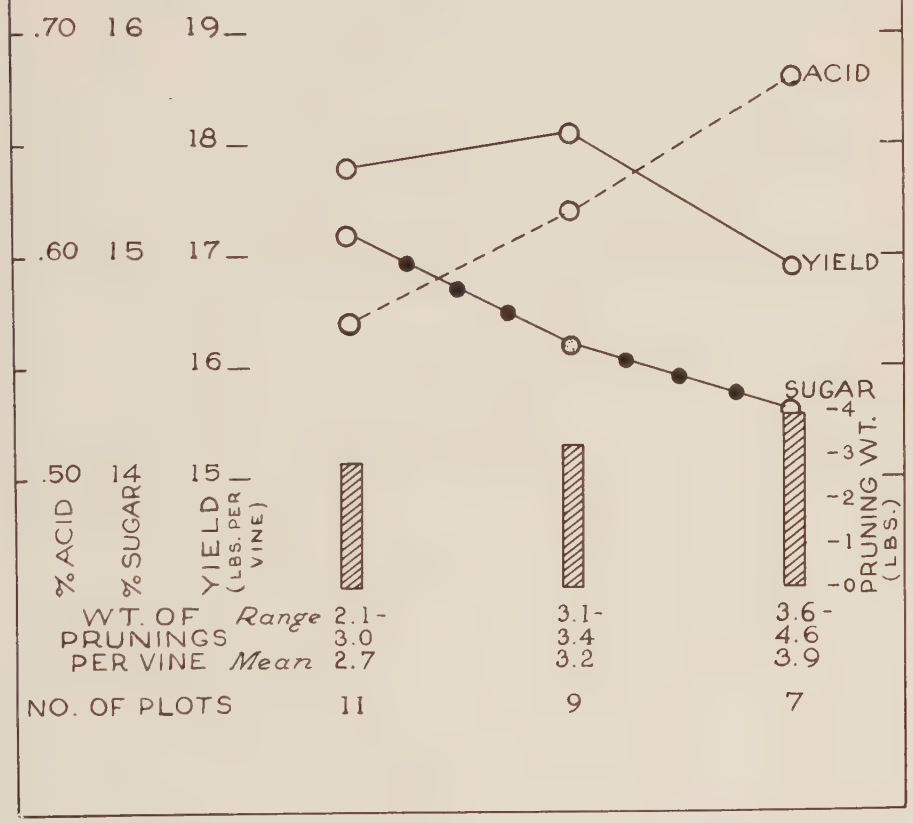
[3] Classified Vineland Clay Loam by the Department of Chemistry, Ontario Agricultural College,—moderately acid in reaction, medium in organic matter and nitrogen content, for the most part very low in readily soluble phosphorus; subsoil heavy with restricted internal drainage

FIGURE I: PRUNING WEIGHTS, YIELD, SUGAR AND ACID CONTENT OF CONCORD GRAPES ON UNTREATED PLOTS OF THE HAINES VINYARD 1932 + 1933.



i.e., highest sugar and lowest acid. It must be pointed out, however, that these vines should be considered as comparatively weak growing only, as even the least vigorous plot averaged 2.1 lb. of prunings which represents very little below average vigour for the Concord variety. It is probable, though not proven as far as the authors are aware, that very weak growing vines pruned to the same numbers of buds would give fruit of inferior quality as measured by sugar and acid content. Though the very vegetative plots have fallen down in yield of fruit *they have also shown quality inferior to the less vegetative plots.* The very vegetative condition of the vines has affected the quality of the grape relatively more in acid content than in sugar content. Other data obtained by the authors have

shown that in the later stages of ripening acid is reduced at a greater rate than sugar is increased.

These results indicate that growers, by overpruning *strong growing* Concord grape vines, are not only reducing the quantity but probably also the quality of the crop, or putting it another way, the very vegetative condition may result in a later ripening fruit. In the Niagara district this is an undesirable condition as it is important to hasten rather than delay the ripening of Concord. It is, of course, an easy matter for a grower to avert the strongly vegetative condition by lighter pruning, *i.e.*, leaving more buds at pruning time. Only by pruning according to the present vigour of the vine can a maximum crop of high quality fruit be obtained.

REVUE

Kolb, J. H. et Polson, R. A. Trends in Town-Country Relations, Research Bulletin 117, Agricultural Experiment Station, University of Wisconsin and the United States Department of Agriculture Co-operating, pp. 35.

L'étude des rapports qui existent entre la ville et la campagne est importante car elle démontre la nécessité de développer simultanément ces deux domaines. Les résultats d'une étude de ce genre conduite dans le comté de Walworth, Wisconsin, en 1929, sont présentés dans ce bulletin et comparés à ceux d'une étude semblable, faite en 1913.

Il y a eu des changements également dans sept services principaux. L'étendue desservie par les services de bibliothèque a augmenté de 158% depuis 1913. C'est l'école secondaire qui a le plus contribué à ce changement. L'étendue du pays fournissant du lait en nature a fait une augmentation nette de 64 pour cent par suite de l'amélioration des chemins, de l'emploi d'auto-camions et de la tendance à la centralisation du contrôle. L'expansion nette dans l'étendue desservie par les écoles secondaires a été de 49%. La population rurale varie de 40 à 50% du total, suivant la dimension du centre. Les services d'épiceries se sont développés de 22%. On trouve maintenant des magasins à chaîne dans tous les centres dont la population dépasse 700 personnes. Le vieux magasin général a été remplacé par un type de magasin qui ne porte que quelques lignes de marchandises. Il n'y a pas eu, en somme, d'augmentation sensible dans l'affiliation des gens de campagne avec l'église du village ou de la petite ville. Le goût des gens de campagne a changé si rapidement que les méthodes d'affaires n'ont pu être modifiées à temps pour le satisfaire. Ce sont les centres des services bancaires qui ont le moins changé; six centres ont perdu du territoire tandis que cinq en ont gagné. Les services bancaires, de même que les services d'épiceries ou d'habillements paraissent se concentrer autour de ces hommes et de ces institutions qui s'efforcent de donner un type modèle de service adapté aux résidents de leur pays, de leur village et de leur ville.

En général les familles de ferme utilisent quatre centres de service par famille, savoir, un centre à la croisée des chemins, au hameau, ou à un très petit village, un centre de deux villages ou de petite ville ou un centre de ville. On fait également des commandes par la poste. Les centres de campagne sont importants pour les services de marchandises, et pour les services primaires d'instruction et d'église. De plus en plus les petites villes et villages deviennent les centres principaux pour beaucoup des services exigés par les familles de la ferme. On peut affirmer aujourd'hui que la ville et la campagne s'unissent pour former un plus grand groupement rural. Les familles de ferme vont aux centres urbains pour les soins médicaux ou les soins d'hôpitaux, et pour se procurer de bons vêtements, et des meubles.

RESUME DES ARTICLES PUBLIES DANS CE NUMERO

ETUDES DE NUTRITION SUR LE FRAGARIA II. UNE ETUDE DE L'EFFET DU MANQUE ET DE L'EXCES DE POTASSIUM, DE PHOSPHORE, DE MAGNESIUM, DE CALCIUM ET DE SOUFRE. M. B. Davis, H. Hill, et F. B. Johnson, Ferme expérimentale centrale, Ottawa, Canada.

Des plants de fraisiers ont été cultivés en pots, dans du sable stérile, et soumis aux traitements nutritifs que voici: mélange fertilisant complet, excès de potasse, manque de potasse, excès et manque de phosphore, excès et manque de magnésium, excès et manque de calcium, et excès et manque de soufre. On a obtenu des symptômes sur le feuillage qui pouvaient être reliés aux traitements appliqués et qui devraient être utiles dans le diagnostic. Le manque de rusticité pendant l'hiver paraît dépendre du manque de potasse plus que de tout autre traitement. Les données relatives au rendement indiquent qu'un excès de phosphore et de calcium peut nuire à la formation des boutons. La suppression complète du phosphore et du magnésium exerce un effet considérable sur la formation des boutons de fruits, tandis que la suppression complète de calcium et de soufre n'a que peu ou point d'effet. Les plantes paraissent capables d'utiliser à nouveau une proportion considérable de leur potassium original. Les analyses des tiges (feuilles et collets) pour les hydrates de carbone indiquent l'effet considérable du potassium sur l'accumulation d'hydrates de carbone. L'analyse de la matière minérale des feuilles révèle l'effet des différents traitements sur la composition des cendres et de la matière sèche. Tous les traitements par omission ont résulté en une réduction, dans la cendre et dans la matière sèche, de l'élément omis. Un antagonisme a été révélé entre le calcium et le potassium, et le phosphore et le potassium. Aucun symptôme de manque de potassium et de manque de phosphore n'a été noté sur le feuillage dans la série qui ne recevait pas de calcium, de magnésium ou de soufre, et l'on a constaté, d'autre part, une proportion élevée de ces deux éléments dans les cendres et dans la matière sèche. Des chiffres présentant les corrélations significatives suivantes sont présentés: corrélation négative entre CaO et K_2O dans les cendres; corrélation positive entre MgO et P_2O_5; corrélation négative entre K_2O et MgO, corrélation négative entre P_2O_5 et K_2O dans les cendres.

VARIATION DE LA DIFFERENCE ENTRE LES SEXES DANS LA CROISSANCE DES POUSSINS. S. Bird et H. S. Gutteridge, Service de l'aviculture, Ferme expérimentale centrale, Ottawa, Canada.

Les données dont il est fait rapport dans cet ouvrage semblent indiquer que la différence normale entre les sexes, au point de vue de la rapidité de la croissance et de la croissance absolue, peut être sensiblement influencée par les conditions environnantes. Il a été constaté dans le groupe témoin qu'un sexe était très fortement affecté tandis que le sexe opposé, soumis à un traitement identique, ne l'était que peu ou point. Il est évident également que la réaction différente de ce sexe aurait passé inaperçue si les données avaient été traitées comme si elles venaient d'une population mélangée, et qu'elle aurait été complètement obscurcie si les facteurs de conversion avaient été employés. Les données recueillies par d'autres investigateurs indiquent une situation semblable ou inverse, et l'on en conclut donc que les données relatives à la croissance chez les volailles, mélangées ou converties, peuvent induire en erreur et ne devraient pas être employées.

RENDEMENT ET QUALITE DES FRUITS PROVENANT DE VIGNES CONCORD A FORTE VEGETATION. W. H. Upshall et J. R. VanHaarlem, Station expérimentale d'horticulture, Vineland Station, Ont., Canada.

Les résultats obtenus dans un vignoble commercial en 1932 et 1933 indiquent que les producteurs, en pratiquant un excès de taille sur des vignes Concord à forte végétation, non seulement réduisent la quantité mais abaissent probablement aussi la qualité de la récolte, parce que la maturation des fruits est retardée. C'est là un résultat déplorable dans le district de Niagara, où il est important de hâter plutôt

que de retarder la maturation des raisins Concord. Il est sans doute facile pour le producteur d'éviter cette végétation exagérée en pratiquant une taille moins rigoureuse, c'est-à-dire en laissant plus de boutons à l'époque de la taille. Que l'on se base donc, pour la quantité de taille à effectuer, sur la vigueur de la vigne; c'est le seul moyen d'obtenir une grosse récolte de fruits de haute qualité.

CURRENT PUBLICATIONS

PEAT, MUCK AND MUD DEPOSITS. THEIR NATURE, COMPOSITION AND AGRICULTURAL USES. Frank T. Shutt and L. E. Wright, Chemistry Division, Central Experimental Farm, Ottawa. Dominion of Canada, Department of Agriculture Bulletin No. 124—New Series.

Peat and muck receive most of the space in this bulletin. There is a general description of the nature of these soils, followed by two tables giving analyses of samples from many localities. The uses and treatments of peat and muck as soil amendments, compost, and absorbent litter, and in horticulture are all discussed, while there is a valuable section on the reclamation of peat and muck lands with special reference to the work done at the Illustration Station at Caledonia Springs, Ontario. There is a short section on tidal muds, mussel and oyster shell muds, and pond, lake and river muds. This publication is a concise and practical bulletin covering the general value and use of these soils.

THE BROODING AND REARING OF CHICKS. F. L. Wood, Poultry Superintendent, New Brunswick Department of Agriculture, Fredericton, N.B. Bulletin No. 39.

This is a farmer's bulletin containing much standard information on the brooding and rearing of chicks. Particular reference is made to rations suitable to local conditions and to the work done by the New Brunswick Department in establishing pullorum-free flocks.

THE WORLD WHEAT PROBLEM AND THE LONDON AGREEMENT. Published by the Authority of the governments of the Dominion of Canada and of the Provinces of Manitoba, Saskatchewan, and Alberta.

It is not possible to summarize this publication, as it is itself a summary of some of the factors entering into the very complicated problem of wheat marketing. The pamphlet was prepared for distribution to wheat farmers in Western Canada. It sets out clearly and distinctly the problem of increased carry-over and asks for support and co-operation in carrying out whatever measures may be evolved to prevent an increase in total production and make possible a decrease in carry-over. It does not attempt to outline the steps to be taken to carry out Canadian obligations under the Wheat Agreement, but it is a useful and convenient publication from which to quickly get a comprehensive view of the general problem itself. Copies are available from the governments concerned.

JOHNE'S DISEASE OF CATTLE. G. Hilton, Veterinary Director General, Health of Animals Branch, Ottawa. Dominion of Canada, Department of Agriculture Bulletin No. 167—New Series.

The introduction to this bulletin states that "Although this disease is not prevalent in Canada, this pamphlet has been prepared with a view to giving cattle breeders and owners the available information to assist them to recognize or suspect it when it does occur, and so enable them to guard their interests by taking prompt measures to control the disease, and to prevent its spread. Much depends upon the alertness of the live stock owner in detecting disease, his promptitude in isolating affected animals and reporting to the authorities, as to whether the infection is quickly controlled or a serious outbreak develops."

There is no known cure for Johne's disease after symptoms develop and no available system of immunization. Treatment must be restricted to preventive measures. This disease has not been brought under the provisions of the Animal Contagious Diseases Act, but the Health of Animals Branch is prepared to render assistance in identifying infection. A description is given of the symptoms, and control measures are outlined

THE ECONOMIC ANNALIST

A REVIEW OF AGRICULTURAL BUSINESS PREPARED QUARTERLY BY THE AGRICULTURAL ECONOMICS BRANCH, DEPARTMENT OF AGRICULTURE, OTTAWA

Vol. IV, No. 1. March, 1934

THE ECONOMIC SITUATION

PREPARED IN THE AGRICULTURAL ECONOMICS BRANCH, DEPARTMENT OF AGRICULTURE, OTTAWA, FROM BASIC DATA COLLECTED BY THE DOMINION BUREAU OF STATISTICS

The index number of wholesale prices in Canada showed a substantial gain in February, being 1.5 points above the index for January. The sub-indexes for vegetable products, animals and their products, fibres, textiles and textile products, wood, wood products and paper, iron and its products, advanced; non-ferrous metals and their products, and non-metallic minerals and their products declined, while chemicals and allied products remained unchanged.

Retail Prices.—The index number of retail prices and costs of services advanced from 78.7 in January to 79.2 in February. Increased prices of food products were entirely responsible for the rise in the index number. February was the fifth consecutive month in which an advance in retail prices has been registered.

Employment.—The adjusted index of employment advanced from 96.5 at the first of February to 97.4 as at the first of March. Employment is, therefore, being more than maintained. It is of special significance that considerable improvement took place in manufacturing industries.

Physical Volume of Business.—The physical volume of business receded fractionally in March. The index for February was 86.4 as compared with 86.8 in January. Industrial production was also a little lower, declining from 84.5 to 84.0. Mineral production fell from 120.6 to 117.2. Output of copper and nickel was lower but lead, zinc, and silver production was higher. There was little change in output of gold.

The index of manufacturing registered a substantial gain from 80.7 in January to 83.2 in February. Advances in milling, lumbering, textile imports, and automobile construction were the chief factors contributing to the improvement. The index of iron and steel production was lower because of recessions in pig iron, steel production, and imports of iron and steel. Construction continued at low levels, being even lower than in January. There is still prospect for improvement in this industry when spring opens up.

Agricultural Products.—Wholesale prices of Canadian farm products advanced from 55.3 in January to 58.0 in February. This was largely due to improvement in prices of animal products, this index rising from 67.8 to 72.5. While the advances were not uniform practically all classes of stock sold at higher prices Supplies of eggs fell off sharply and prices therefore rose rapidly. Butter prices were also higher.

Agricultural marketings were much higher in February, the total index being 67.1 as compared with 48.2. Animal marketings rose from 77.6 to 94.0 while those of grain were 61.1 as against 41.6 in January. The movement of wheat was not much higher than in the previous month but that of oats and barley was much larger. Shipments of flax were about the same as in January, while rye moved in slightly larger volume.

Cold Storage Holdings.—The index of cold storage holdings fell to 98.6 at the first of February and a further depletion of stocks has resulted in a decline in the index to 97.0 at the first of March. It will be noted that these indexes are below

ANNUAL AND MONTHLY INDEX NUMBERS OF PRICES AND PRODUCTION COMPUTED BY DOMINION BUREAU OF STATISTICS

Year	Wholesale Prices 1926 = 100				Retail prices and cost of services (5)	Production (6) 1926 = 100			
	All commodities (1)	Farm products (2)	Field products (3)	Animal products (4)		Physical volume of business	Industrial production	Agricultural marketings	Cold Storage holdings
1913	64.0	62.6	56.4	77.0	65.4				
1914	65.5	69.2	64.9	79.0	66.0				
1915	70.4	77.7	76.9	79.2	67.3				
1916	84.3	89.7	88.4	92.3	72.5				
1917	114.3	130.0	134.3	119.6	85.6				
1918	127.4	132.9	132.0	134.7	97.4				
1919	134.0	145.5	142.4	152.5	107.2	71.3	65.5	48.1	47.1
1920	155.9	161.6	166.5	149.9	124.2	75.0	69.9	52.6	94.2
1921	110.0	102.8	100.3	108.5	109.2	66.5	60.4	65.2	86.4
1922	97.3	86.7	81.3	99.1	100.0	79.1	76.9	82.6	82.8
1923	98.0	79.8	73.3	95.1	100.0	85.5	83.8	91.4	87.6
1924	99.4	87.0	82.6	97.2	98.0	84.6	82.4	102.5	114.9
1925	102.6	100.4	98.1	105.7	99.3	90.9	89.7	97.2	108.6
1926	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.9	100.0
1927	97.7	102.1	99.9	105.7	98.4	106.1	105.6	103.6	110.0
1928	96.4	100.7	92.6	114.3	98.9	117.3	117.8	146.7	112.8
1929	95.6	100.8	93.8	112.5	99.9	125.5	127.4	101.1	109.6
1930	86.6	82.3	70.0	102.9	99.2	109.5	108.0	103.0	128.4
1931	72.2	56.3	43.6	77.6	89.6	93.5	90.4	99.0	125.7
1932	66.7	48.4	41.1	60.7	81.4	78.7	74.0	114.3	120.1
1933									
Jan.	63.0	43.6	35.1	57.9	79.1	68.1	62.2	56.1	112.0
Feb.	63.6	43.0	36.0	54.7	78.4	67.0	60.0	76.5	127.6
Mar.	64.4	44.7	38.0	56.0	77.8	68.4	62.5	129.0	135.8
April	65.4	46.8	41.1	56.4	78.1	69.8	65.1	104.1	112.7
May	66.9	51.2	46.9	58.4	77.0	76.4	72.7	95.4	110.4
June	67.6	52.6	49.4	57.9	77.0	82.2	79.8	221.9	119.9
July	70.5	60.1	60.8	59.0	77.2	84.1	82.6	221.9	119.9
Aug.	69.4	57.0	54.9	60.5	78.6	89.8	89.5	197.2	114.2
Sept.	68.9	54.7	49.5	63.4	78.8	90.8	90.2	101.1	115.7
Oct.	67.9	51.4	44.6	62.8	77.9	88.2	87.4	70.5	112.7
Nov.	68.7	53.8	46.7	65.8	78.1	85.5	83.9	41.8	111.1
Dec.	69.0	53.3	45.3	66.6	78.4	86.2	85.1	30.7	107.6
1934									
Jan.	70.6	55.3	47.9	67.8	78.7	86.8	84.5	48.2	108.1
Feb.	72.1	58.0	49.3	72.5	79.2	86.4	84.0	67.1	98.6

1. See Prices and Price Indexes 1913-1928, pp. 19-21, 270-289 and 1913-1931, p. 15.

2. Wholesale prices of Canadian products of farm origin only. See Prices and Price Indexes 1913-1931, p. 33, and Monthly Mimeographs 1932 and 1933.

3. Wholesale prices of grains, fruits and vegetables.

4. Wholesale prices of Animals and Animal Products.

5. Including foods, rents, fuel, clothing and sundries, See Prices and Price Indexes 1913-1928, pp. 181-185, 290-293. 1926=100.

Prices and Price Indexes 1913-1931, p. 122, and Monthly Mimeographs 1932-1933.

6. Monthly Review of Business Statistics, p. 8, and Monthly Indexes of the Physical Volume of Business in Canada, supplement to the Monthly Review of Business Statistics, November, 1932.

the base period of 1926 and this indicates a decided improvement in the rate at which food products are being moved into consumption.

Marketing Policies.—Interest in revision of marketing policies continues. More schemes are being prepared in the United Kingdom. New Federal and State Legislation has been introduced in Australia. The United States program is being pushed ahead vigorously. The Honourable Robert Weir has given notice of his intention to introduce legislation to improve the marketing of agricultural products in Canada. The immediate cause of the dissatisfaction with marketing services is, of course, to be found in the low prices of agricultural products which prevailed

between 1920 and 1924 and since 1929. This situation has given rise to the feeling that improvement in marketing is not only desirable but imperative. While these "short time causes" are of great importance, the changes in agricultural production, in the technique of agriculture, the distribution of population, the transport of food products, together with the improvements in marketing methods which have taken place during the last half century or more are not to be overlooked. New areas of production have been opened up. Products now reach export markets in quantities hitherto regarded as impossible of achievement. These factors have exerted an influence on both foreign and domestic markets and the organization of industry.

The tendency towards concentration of business in larger units suggests the need of a greater degree of governmental control, for while economies can undoubtedly be effected through large scale operations, the additional strength gained through the organization of big business calls for the establishment of metes and bounds in industrial relations.

The tendency towards further governmental support in marketing at present has undoubtedly been influenced by the war-time policies of purchasing and distributing products under Boards set up by governments for specific purposes. In the minds of those who have experienced difficulties in marketing, the operation of these Boards have often been associated with high prices and for the most part honesty and efficiency. Therefore, while present proposals are not modelled after the war time Control Boards, the influence of such organizations cannot be overlooked.

Having experienced low prices for a period of years farmers now seek a means of co-ordination of marketing services in such a way that more effective distribution can be secured, and for the most part seek legislation which will enable them to secure such a form of organization as will bring this about. Such plans are frequently supported, moreover, even by those who might otherwise be opposed because of the pressure of international competition which focuses attention on the policies adopted in other countries and the ways and means of holding old markets and developing new outlets wherever possible.

The present may be regarded as an experimental stage, but despite this, the tendency in the future is likely to be in the direction of more regulation rather than less.

The following news item concerning imports of dairy products to Great Britain was taken from British newspaper reports. "Unable to deal satisfactorily with the condition of the butter and cheese markets by regulation of imports, the Government has felt obliged to come to the assistance of the dairying industry by guaranteeing minimum prices for butter and cheese for the two years beginning April 1 next". Supplies of dairy products from the Dominions have been on the increase to the British market and moreover they show no sign to diminish in quantity. Cheese and butter from the Dominions enter free of duty under the Ottawa agreements so the British farmer had little to gain in raising the import duty on foreign products. The Dominions have shown little inclination to accept the view that restriction of shipments of either butter or cheese to the British market is in their own interests. The Governments' alternative, therefore, is to subsidize the British farmer in the production of these products. Though the Government has decided against restrictions on the imports of butter and cheese, it has taken action in regard to other milk products, the imports of which have been subject to regulation since the middle of last year. The Dominions were asked to restrict imports of condensed, whole and skim milk, milk powder and cream from June to December, 1933, to the same level as in the corresponding period in 1932. The principal foreign countries, namely, the Netherlands and Denmark, were asked to limit their exports during this period to 80% of the quantities sent in the last seven months of 1932, with the exception of December when the proportion was raised to 85%.

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THE COST OF MANUFACTURING CHEESE IN QUEBEC

J. F. Booth[1] and C. V. Parker[2]

An article on the cost of producing cheese in Ontario was presented in a previous issue of this periodical[3]. In this article a similar review is given of the costs of operating 120 cheese factories situated in the counties of Lac St. Jean, Chicoutimi, Beauce, Arthabasca, Yamaska, Megantic, and Wolfe in the Province of Quebec.

The development of the cheese industry in Quebec has been very similar to that of Ontario. Between 1864, when the first cheese factory was established in Ontario, and 1870, several factories were built in the county of Missisquoi, Quebec. A rapid development in factory building and production took place until 1900-04. In 1900, production of factory cheese was 80,630,999 pounds. Since 1904, however, a decline in production has taken place. The total output in 1931 amounted to 25,907,691 pounds. Despite this rapid decline cheese production is still a major industry in the province and demands recognition in any program of research designed to improve dairying as a whole.

The problems confronting the cheese industry in Quebec are also quite similar to those of Ontario. In both provinces declining volume of output has had a tendency to raise production costs per unit of product manufactured.

The effect has been somewhat greater in Quebec, however, because factories there are considerably smaller than in Ontario. The average production per factory in Quebec in 1931 was 23.3 tons while in Ontario it was 81.47 tons, according to the data collected in the survey.

Costs of Manufacturing Cheese.—Costs of production are presented in the accompanying tables according to two methods of calculation. In method I the actual rates paid by the patrons to have their milk converted into cheese have been taken. These rates represent the charges which private owners of factories levied and the set deductions which patron-owned concerns made from the sale value of the cheese in 1931. In addition, patron organization costs, which include salaries of officials, milk testing and stationery, have been added to the rates charged by private owners. Method I then deals with costs as the patrons think of them.

The cost of operation based on actual charges to patrons as described under method I is presented in Table 1. Factories were classified according to the pounds of cheese produced. The costs for the smallest group, producing under 40,000 pounds averaged 1.86 cents per pound. For the largest factories, 80,000 pounds and over,

TABLE 1.—RELATIVE COSTS OF MANUFACTURING CHEESE AS INDICATED BY TWO METHODS OF CALCULATION

Size of factory (Pounds of cheese)	Method I. Actual rates charged		Method II. Costs, including interest and depreciation at established rates		Difference between two methods
	No. of factories	Cost per pound (cents)	No. of factories	Cost per pound (cents)	(cents)
Under 40,000	46[1]	1.86	47	3.02	1.16
40,000 – 59,999	53	1.85	53	2.49	0.64
60,000 – 79,999	9	1.78	9	2.04	0.26
80,000 and over	11	1.83	11	2.18	0.35
Total or average	119	1.84	120	2.52	0.68

[1] One factory omitted—no actual rate charged.

Note.—Average expense per factory: Method I, $858.53: Method II, $1,174.37.

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[3] See The Economic Annalist, Vol. III, Nos. 10, 11, 12, pp. 99–102, and Scientific Agriculture, No. 15, pp. 269–272.

costs were 1.83 cents per pound. The average expense for all factories was $858.53 per factory or 1.84 cents per pound of cheese.

It was found on examining the costs as given by method I that all charges were not fully met. Factory owners and managers of patron concerns did not make adequate allowance for depreciation and interest in arriving at the rates to be charged for cheese production. Slightly more than half of the Quebec factory owners were charging 15% of the value of the product made. In 1931, when cheese was selling at around 11 cents, the receipts to these makers only averaged 1.60 to 1.70 cents per pound whereas when cheese prices were higher they were receiving from 2 to 3 cents per pound. Consequently eleven of the 100 owner-makers actually had cash deficits while the majority did not receive sufficient to cover cash costs, interest, depreciation and a living wage. The other owner-makers were charging from $1\frac{3}{4}$ to $2\frac{1}{8}$ cents per pound, but though they were receiving more than those who worked on a percentage basis, they too were unable to meet all the expenses incurred when depreciation and interest costs were adequately provided for. The same may be said of the 20 factories which were owned by the patrons; in many cases patrons actually lost part of their capital in 1931 by not adequately covering depreciation.

The general practice in cheese factory operation is to meet replacement costs as they occur, but owing to the retrenchment which was taking place in 1931 many factory owners probably spent less than usual on capital items. It was found that expenditures to meet depreciation (*i.e.*, new equipment for replacement purposes and reconstruction of buildings) was $6,156.00 for the 120 factories which amounted to only 30.8% of the estimated depreciation for the year of the study. The amounts spent on some factories were greater than for others and of course rates of depreciation do vary in different factories. In order, however, to place all concerns on the same basis and also to take into consideration all the costs incurred in factory operation, method II was adopted.

The costs as listed under method II, Table 1, are made up of the following charges: (1) the actual cash operating expenses (excluding sums spent on capital items and wages to makers); (2) interest on capital invested at 5%, depreciation on frame buildings at 5% and on brick or stone structures at 3% of the present value, and depreciation on equipment calculated on the "years future use" basis; present values and years future use were obtained for the major items of equipment; by dividing the years into the present value a depreciation figure for the year of the study was obtained; (3) makers' salaries taken from estimates derived from makers and also by deducting their expenses from the amounts they received.

TABLE 2.—RANGE OF COSTS PER POUND FOR MANUFACTURING CHEESE

Costs (cents per lb.)	Number in class	Weighted average	Per cent of total	Costs (cents per lb.)	Number in class	Weighted average	Per cent of total
1.5 – 1.99[1]	17	1.84	14.2	4.0 – 4.49	5	4.27	4.2
2.0 – 2.49	47	2.27	39.2	4.5 – 4.99	1	4.83	0.8
2.5 – 2.99	24	2.75	20.0	5 +	1	5.58	0.8
3.0 – 3.49	17	3.26	14.2				
3.5 – 3.99	8	3.63	6.7	Total or average	120	2.52	100.0

[1] The lowest cost was 1.68 cents per pound.

Turning to Table 1 again it can be seen that the average cost per pound for manufacturing cheese was 2.52 cents when all charges were taken into account (method II). The data reveal a wide difference in cost between actual rates charged and cost of operation including interest and depreciation in the first two groups of factories. It would appear that a rate ranging from 2.5 to 3 cents per pound would have to be charged when production per factory was less than 60,000 pounds in order that all expenses might be met. In the larger factories total charges were more

nearly in line with actual rates received than in the smaller units. In the last two groups of factories a rate of 2 2⅛ cents per pound would be sufficient to cover all costs.

The Effect of Volume on Costs.—Besides portraying the difference in costs between methods I and II, Table 1 also shows the effect of volume on costs of production. Factories in which production was less than 40,000 pounds had a cost of 3.02 cents per pound when all items of expense were included while the rate in the largest concerns was 2.18 cents, a difference of 0.84 cents per pound. One of the 11 factories in this larger group, however, had exceptionally high costs, and when it was excluded the other 10 averaged 2.03 cents. Thus, the trend in costs from small to large groups was definitely downwards.

An analysis of the individual items of expense, the data for which are not included in this article, showed that decreases in interest, depreciation and labour costs per unit of product were chiefly responsible for the reduction in cost of manufacture as volume of production increased.

In Table 2 the influence of volume of production is also shown. It was found that the extreme range in costs was from 1.68 to 5.58 cents per pound, a difference of 3.90 cents. The 5.58 cent rate was for the smallest factory while the 1.68 cent figure was for one of the larger plants.

TABLE 3.—COMPARISON OF COST PER POUND OF CHEESE OF MAIN ITEMS OF EXPENSE BY AREAS

Main items of expense	Cost per pound of cheese (cents per pound)			
	Combined area 120 factories	Northern area 60 factories	Southern area 60 factories	Difference Northern over Southern
Boxes	.277	.322	.232	.090
Supplies	.255	.293	.218	.075
Fuel	.200	.245	.156	.089
Taxes and insurance	.105	.154	.055	.099
Organization salaries	.043	.044	.042	.002
Hired labour and board	.080	.092	.068	.024
Maker's salary	.861	.825	.897	—.072
Other factory expense	.037	.048	.026	.022
Repairs	.048	.060	.036	.024
Interest	.257	.318	.196	.122
Depreciation	.358	.444	.272	.172
Total expense	2.521	2.845	2.198	.647

Cost of Production by Areas.—Manufacturing costs varied considerably between the northern and southern area of Quebec. The northern area comprises Lac St. Jean and Chicoutimi Counties and is represented in this study by 60 factories, while the cheese producing area south of the St. Lawrence (the southern area) is also represented by 60 factories. In Table 3, the costs for the main items of expense, together with the total expense per pound of cheese, are listed for each of the districts and for the combined area. The total expense averaged 2.845 cents per pound in the north and 2.20 cents in the south. Every item of expense except that of makers' salary was found to be considerably higher in the northern area than it was in the southern area. The higher costs for boxes, supplies, fuel and repairs were due to the distance of northern factories from distributing centres for these items. A recently constructed water system or aqueduct was responsible for the higher taxation in the north. Interest and depreciation were greater because average factory valuations in the north were $900 higher than in the south. In all, the difference in cost of manufacturing between the two areas averaged 0.647 cents per pound of cheese, or $300 per factory, despite the fact that there was only 50 pounds difference in average production of cheese per factory as between the two areas.

Summary and Conclusions.—Cheese factory production in the province of Quebec has been declining since the early years of the present century. Decreased volume of production in factories which even under more favourable conditions had small turnovers, is resulting in high cost of production per unit of product. In seeking a solution to this problem the suggestion has frequently been made that cheese factory districts should be consolidated and many of the factories closed. It may be said that the difference in costs incurred by factories included in this study is not large enough to warrant a strong case being made for factory consolidation. It should be noted, however, that the real possibilities in this connection cannot be demonstrated in factories of this size. In order to obtain minimum costs the production per factory should be very much larger than any included in this study.

The data obtained, however, indicate that a considerable saving can be made in costs by having a greater volume per factory. This is achieved by making maximum use of labour, plant and equipment. In many cases greater volume could be obtained by the amalgamation of factory districts and by the closing of unnecessary factories. This, in turn, would mean longer hauls for patrons or the organization of milk routes.

There were no milk routes in connection with any of the 120 factories studied in Quebec as practically all the patrons lived within two miles of a factory. Route hauling, therefore, would be a complete change from the present system. The type and condition of roads as well as costs would have to be considered before patrons decided to make this change.

An alternative to consolidation as a means to lowering costs would be an endeavour to increase volume of output per factory by other methods. This might be done by increasing the number of patrons per factory or by adding to the volume of milk delivered by each patron. At present there is an average of 20 patrons per factory in Quebec who, as a rule, have about 9 or 10 cows. Factories operate nearly 6 months in the year and in this period an average of 2,438 pounds of milk per cow is delivered. Much could be done to increase volume of cheese production by lengthening the period of factory operation and by increasing the production per cow.

The present charges for cheese manufacture will have to be raised if many of the factory owners are to remain in business. This is particularly true in cases where the rate charged is set as a percentage of the value of cheese produced. The alternative to higher charges per pound of cheese manufactured is larger volume of production per factory.

According to British newspaper reports an agreement has been reached between the Pigs and Bacon Marketing Boards in regard to the contracts for bacon pigs for the 10-month period commencing March. The price has already been fixed for the first two months at 12s. 6d. per score for a basic pig in Class 1. This price will be subject to a levy of 6d. per score to repay the co-operative loan which was advanced to cover curers' losses in the last contract period. For the following eight months the price will be based on the cost of producing the pig, the cost of curing it into bacon, and the selling price of bacon. In this way the producer will share in the whole process.

The Canadian Federation of Dairy Farmers was organized at Ottawa on March 15th. A. H. Mercer, Fraser Valley Milk Producers' Association, Vancouver, was elected president. J. F. Desmarais, Co-operative Fédérée de Quebec, and W. A. Amos, United Farmers' Co-operative Company, Toronto, were elected vice-presidents, and H. B. Cowan of Peterborough was appointed secretary-treasurer.

Press reports state that Dr. Wm. Allen, who was appointed a Royal Commissioner to inquire into the marketing of milk in Saskatchewan has recommended that a plan of control similar to that inaugurated under the Manitoba Public Utilities Commission in 1932 and adopted in Alberta in 1933 be inaugurated in Saskatchewan. The report, it is understood, will be the basis of legislation to be introduced at the present session of the Legislature.

BUSINESS ANALYSIS OF THE OPERATIONS OF TEN CO-OPERATIVE FRUIT COMPANIES IN NOVA SCOTIA[1]

A. E. Richards[2]

Returns are received by the Agricultural Economics Branch annually on a voluntary basis from farmers' business organizations throughout Canada. These are grouped provincially under commodity headings, and the business operations of certain groups are analysed on a comparable basis in order to bring out strong and weak points in the organization of individual companies.

In 1932, for Canada as a whole, returns were received from 110 co-operative companies handling fruit. These companies reported combined shareholders and members numbering 8,232 who contributed to a total business of $7,679,713. The Nova Scotia returns for the same year were received from 44 companies with a membership of 1,086 who reported $1,487,209 of business.

The combined and comparative balance sheets and operating statements of ten Nova Scotia fruit companies are shown in Tables 1 and 2 for the year ending May 31, 1931. Returns for that period are used in this analysis as they were more complete than for the year 1932.

The season 1930-31 and the two or three years preceding brought unusual difficulties for the fruit grower in a disorganized export market and low prices. In order to tide the grower over what was looked upon as a temporarily bad situation, and to hold his patronage, companies sold their feed and supplies on credit. This in turn led to borrowings on the part of the companies which resulted in heavy indebtedness and high interest charges. To meet competition or satisfy patrons, operating margins were narrowed to a point where some companies were not covering overhead. This situation is reflected in the financial statements of the companies in Tables 1 and 2.

Assets.—Accounts and notes receivable under current assets amount to $141,191.36 (Table 1). For most companies this figure indicates a liberal credit policy which once instituted is difficult to overcome. It results in a heavy load for the companies to carry, for on the other side of the balance sheet under current liabilities, we find an equivalent sum for accounts payable. Merchandise inventory is a sizeable item due to the fact that nearly half of the business of these fruit companies is derived from the sale of merchandise and supplies. With the fiscal year closing in the spring of the year, stocks of fertilizer and other supplies are probably higher than in some other seasons when the balance sheet items would show quite a different relation to one another.

The combined value of plant and equipment, including real estate, totals $161,010.22 or 41.7% of total assets. The ratio of business to plant value (Table 3) for all companies is 3.14 to 1 which means that on the average the companies did $3.14 of business for each $1.00 plant value. Some companies show a higher ratio, which usually means a more intensive use of plant and equipment, and this in turn is associated with a proportionally lower overhead.

Debt and Net Worth.—Accounts payable is a large item amounting to $143,386.90 or 37.2% of all liabilities and net worth. Bank loans appear unduly large also, amounting to $63,038.88 which is 16.3% of all liabilities and net worth. Along with other current liabilities the total assumes larger proportions than is generally considered desirable. The ratio current assets to current liabilities brings out the situation more clearly but less encouragingly. Table 3 shows the ratio for all companies which stands 0.91 to 1 and means that all companies combined have 91 cents of readily convertible assets for each $1.00 of current indebtedness. Company K shows a comparatively strong position in this regard but other companies are considerably below what is considered the standard for many types of business.

[1] This article deals with a section of a report on farmers' business organizations in Canada awaiting publication by the Agricultural Economics Branch.

[2] Agricultural Economist, Department of Agriculture, Canada.

TABLE 1.—COMPARATIVE BALANCE SHEETS OF TEN CO-OPERATIVE FRUIT COMPANIES IN NOVA SCOTIA AS AT MAY 31, 1931*

	Total all companies		K	L	M	N	O	P	Q	R	S.	T
	$	%	%	%	%	%	%	%	%	%	%	%
Cash on hand and in bank	5,077.55	1.3	4.3	0.4	2.4	—	—	3.0	4.4	0.5	0.9	0.9
Accounts and notes receivable	141,191.36	36.6	31.4	36.5	47.2	20.4	22.5	15.5	44.4	32.2	70.1	31.5
Merchandise inventory	66,491.73	17.3	17.8	1.9	9.6	30.1	24.0	30.3	19.7	35.3	5.9	11.8
Other	2,643.18	0.7	0.9	1.4	1.3	—	—	1.1	0.3	0.9	—	0.3
Total current assets	215,403.82	55.9	54.4	40.2	60.5	50.5	46.5	49.9	68.8	68.9	76.9	44.5
Plant, less depreciation	161,010.22	41.7	43.4	58.5	30.1	46.4	47.0	46.8	28.8	30.1	21.8	52.6
Other	9,200.00	2.4	2.2	1.3	9.4	3.1	6.5	3.3	2.4	1.0	1.3	2.9
Total fixed assets	170,210.22	44.1	45.6	59.8	39.5	49.5	53.5	50.1	31.2	31.1	23.1	55.5
Total assets	385,614.04	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LIABILITIES AND NET WORTH												
Accounts payable	143,386.90	37.2	23.8	49.2	38.3	40.8	36.0	20.3	30.5	28.7	102.5	18.2
Bank loans	63,038.88	16.3	—	3.9	8.8	46.8	37.3	23.7	17.8	24.2	—	20.9
Accrued expenses	2,911.97	0.8	1.0	0.6	0.4	1.5	1.8	0.3	1.0	0.6	0.1	1.0
Other	28,055.00	7.3	—	1.0	12.8	—	—	—	—	9.8	—	19.0
Total current liabilities	237,392.75	61.6	24.8	54.7	60.3	89.1	75.1	44.3	49.3	63.3	102.6	59.1
Mortgages	33,500.00	8.7	26.9	17.7	—	—	—	10.2	14.9	7.4	—	3.9
Total fixed liabilities	33,500.00	8.7	26.9	17.7	—	—	—	10.2	14.9	7.4	—	3.9
Capital stock	90,293.10	23.4	28.9	24.4	33.7	15.9	18.4	14.6	20.2	22.6	8.6	30.4
Reserve for contingencies	4,791.32	1.2	—	—	3.2	—	—	16.8	3.1	—	2.0	—
Other	21,025.55	5.5	5.4	13.0	2.7	—	0.6	7.5	2.2	1.8	4.4	6.7
Surplus	−1,388.68	−0.4	14.0	−9.8	0.1	−5.0	5.9	6.6	10.3	4.9	−17.6	−0.1
Total net worth	114,721.29	29.7	48.3	27.6	39.7	10.9	24.9	45.5	35.8	29.3	− 2.6	37.0
Total liabilities and net worth	385,614.04	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* Individual plants are designated by letters K, L, M, etc.

Along with mortgages of $33,500.00 for all companies total debt to outside interests amounts to $270,892.75 which is greatly in excess of owned capital represented in the net worth. The ratio of worth to debt brings out the real position, which for all companies is .42 to 1 or, in other words, for every 42 cents contributed and held in the name of the members outside creditors have $1.00 invested and expect to be paid back in full, with interest. No company among the ten shows an excess of worth and for some the position is far from satisfactory.

Working capital is the difference between current assets and current liabilities. For the companies combined this is a minus quantity and is suggestive of financial difficulties. Five companies show a small working capital of less than 1% of total assets.

A number of companies are without reserves and on the year's operations failed to provide a surplus. For the companies as a whole there is a debit balance of $1,388.68 although six out of the ten show a surplus.

The Operating Statement.—Total business amounted to $506,358.08. Farm products, which consisted almost entirely of apples, sold for $261,412.61. This made up 51.6% of the business. Producers were paid $247,658.43 or 94.73% of the sales price. This is equivalent to an operating margin of slightly over 5%; such a narrow spread, of necessity, means that no reserves could be built up with which to reduce indebtedness. Merchandise and supplies with a sales value of $242,009.52 accounted for 47.8% of the total business. The cost of this merchandise was $226,571.68 which gave a spread of 6.8% to cover handling costs.

An average operating margin of only 5% on fruit sales and 7% on merchandise means that some of the companies are turning back everything to the grower of fruit and providing supplies at cost or less than cost. A company has no chance to establish a sound business structure following such a policy and only a business without creditors and with ample reserves can afford to follow such a course and survive. Members of a co-operative fruit company must realize that the warehouse is as much a part of their property and business as the orchard and requires just as fair treatment and business-like handling.

In the items of expense the charge for wages and salaries was $11,027.61, which amounts to 2.2% of total business. Interest on borrowed money, the other large item, totals $8,427.06 or 1.7% of the total volume of business. Insurance and taxes combined are less than one-half of one per cent. In relation to total expenses wages and salaries use 34.3% and interest 26.2%. For three companies interest was the largest item of expense and exceeded 30%. Total expenses for all companies amounted to 5.8% of total business with individual companies ranging from 3 to 13%. The net operating income or net profit for all companies was $2,970.03. To this was added other income of $23,465.52 which, for many companies, was unapportioned surplus carried forward from the previous year. A small part of the net income for distribution was paid out in dividends but the greater portion was again carried into the next year as undivided income. No allowance was made for patronage refund and nothing was carried to reserve.

Constructive Financial Policy Necessary.—This analysis indicates the need of a definite and constructive financial policy. If, for example, the financial statements of these ten fruit warehouses as shown in Tables 1 and 2 could be considered as representing one large company and if the patrons would agree to stand together and ignore competitors who might offer small immediate gains, in five years the combined statement would present a very different picture.

If the patrons of the company would agree to permit the warehouse to increase its margin by 5% on fruit sales and by 2% on merchandise sales they would still be operating on a comparatively small margin. In other words, they would agree to accept 90 cents of the sales dollar from fruit in place of 95 cents and allow a margin

TABLE 2.—COMPARATIVE OPERATING STATEMENTS OF TEN CO-OPERATIVE FRUIT COMPANIES IN NOVA SCOTIA FOR THE YEAR ENDING MAY 31, 1931*

	Total all companies			K		L		M		N	
	$	% of total business	% of gross margin	% of total business	% of gross margin	% of total business	% of gross margin	% of total business	% of gross margin	% of total business	% of gross margin
Total business	506,358.08	100.0		100.0		100.0		100.0		100.0	
Sales of farm products	261,412.61	51.6		48.0		82.1		84.0		76.6	
Paid to producers	247,658.43	48.9		46.5		77.9		74.4		65.4	
Gross margin	13,754.18	2.7		1.5		4.2		9.6		11.2	
Sales of merchandise	242,009.52	47.8		51.9		15.0		14.9		22.9	
Cost of merchandise	226,571.68	44.7		48.0		12.0		14.0		22.3	
Gross margin	15,437.84	3.1		3.9		3.0		0.9		0.6	
Other receipts	2,935.95	0.6		0.1		2.9		1.1		0.5	
Total gross margin	32,127.97	6.4	100.0	5.5	100.0	10.1	100.0	11.6	100.0	12.3	100.0
EXPENSES											
Wages and salaries	11,027.61	2.2	34.3	0.5	8.9	3.7	36.8	9.3	80.4	7.4	60.5
Rental	—	—	—	—	—	—	—	—	—	—	—
Depreciation	498.54	0.1	1.6	—	—	—	—	0.3	2.1	0.2	1.3
Supplies	977.48	0.2	3.0	0.1	2.8	0.5	4.9	1.0	8.8	—	—
Insurance	1,311.15	0.3	4.1	0.3	4.8	0.4	4.4	0.2	1.7	0.3	2.4
Taxes	1,072.21	0.2	3.3	0.3	4.7	0.7	6.7	0.4	3.1	0.4	3.1
Interest on borrowed money	8,427.06	1.7	26.2	0.7	13.5	2.9	28.9	0.1	0.7	2.3	18.8
Maintenance	5,294.68	1.0	16.5	0.9	16.4	0.6	5.7	0.4	3.7	0.4	3.7
Other	549.21	0.1	1.7	0.4	6.9	0.5	4.6	—	—	0.8	6.3
Total expenses	29,157.94	5.8	90.7	3.2	58.0	9.3	92.0	11.7	100.5	11.8	96.1
Net operating income	2,970.03	0.6	9.3	2.3	42.0	0.8	8.0	−0.1	−0.5	0.5	3.9
Other income	23,465.52	4.6	73.0	7.0	126.8	21.2	210.2	0.1	0.9	−4.3	−34.6
Net income for distribution	26,435.55	5.2	82.3	9.3	168.8	22.0	218.2	0.0	0.4	−3.8	−30.7
Dividends on capital	401.49	0.1	1.3	1.0	19.2	—	—	—	—	—	—
Total apportioned	401.49	0.1	1.3	1.0	19.2	—	—	—	—	—	—
Undivided income	26,034.06	5.1	81.0	8.3	149.6	22.0	218.2	0.0	0.4	−3.8	−30.7

* Individual plants are designated by letters K, L, M, etc.

TABLE 2.—COMPARATIVE OPERATING STATEMENTS OF TEN CO-OPERATIVE FRUIT COMPANIES IN NOVA SCOTIA FOR THE YEAR ENDING MAY 31, 1931*—*Concluded*

	O		P		Q		R		S		T	
	% of total business	% of gross margin	% of total business	% of gross margin	% of total business	% of gross margin	% of total business	% of gross margin	% of total business	% of gross margin	% of total business	% of gross margin
Total business	100.0		100.0		100.0		100.0		100.0		100.0	
Sales of farm products	78.0		62.6		68.2		31.0		42.9		37.1	
Paid to producers	66.0		60.5		67.6		29.0		41.8		35.3	
Gross margin	12.0		2.1		0.6		2.0		1.1		1.8	
Sales of merchandise	21.7		37.0		31.4		67.5		57.0		62.9	
Cost of merchandise	20.4		35.8		27.2		61.3		53.5		61.2	
Gross margin	1.3		1.2		4.2		6.2		3.5		1.7	
Other receipts	0.3		0.4		0.4		1.5		0.1		0.0	
Total gross margin	13.6	100.0	3.7	100.0	5.2	100.0	9.7	100.0	4.7	100.0	3.5	100.0
EXPENSES												
Wages and salaries	8.0	58.9	—	—	2.3	44.3	3.2	32.8	1.3	27.2	—	—
Rental	—	—	—	—	—	—	—	—	—	—	—	—
Depreciation	0.1	0.7	0.2	4.1	0.0	1.0	0.3	2.7	0.0	0.9	0.1	1.8
Supplies	—	—	0.6	16.3	0.1	1.4	—	—	—	—	0.2	5.1
Insurance	0.3	2.5	0.1	3.1	—	—	0.5	5.6	0.1	2.5	0.3	8.2
Taxes	0.6	4.2	0.1	3.3	—	—	0.5	5.7	0.2	4.8	—	—
Interest on borrowed money	2.8	20.6	0.7	18.2	0.8	14.7	3.9	40.3	1.9	39.3	1.3	36.9
Plant maintenance	1.1	7.9	1.7	44.9	0.4	8.6	1.2	12.3	0.3	5.3	1.7	49.0
Other	0.3	2.4	0.0	1.1	—	—	—	—	0.0	0.1	0.0	1.1
Total expenses	13.2	97.2	3.4	91.0	3.6	70.0	9.6	99.4	3.8	80.1	3.6	102.1
Net operating income	0.4	2.8	0.3	9.0	1.6	30.0	0.1	0.6	0.9	19.9	−0.1	−2.1
Other income	4.9	36.2	4.0	106.0	4.1	80.6	5.4	55.7	14.3	302.8	—	—
Net income for distribution	5.3	39.0	4.3	115.0	5.7	110.6	5.5	56.3	15.2	322.7	−0.1	−2.1
Dividends on capital	—	—	—	—	—	—	—	—	—	—	—	—
Total apportioned												
Undivided income	5.3	39.0	4.3	115.0	5.7	110.6	5.5	56.3	15.2	322.7	−0.1	−2.1

* Individual plants are designated by letters K, L, M, etc.

TABLE 3.—RATIO TESTS APPLIED TO OPERATIONS OF TEN CO-OPERATIVE FRUIT COMPANIES IN NOVA SCOTIA FOR THE SEASON 1930-31[1]

	All[2]	K	L	M	N
Current assets to current liabilities	0.91 to 1	2.20	0.74	1.00	0.57
Worth to debt	0.42 to 1	0.93	0.38	0.66	0.12
Business to plant value	3.14 to 1	3.91	0.79	5.32	2.84
Net worth to fixed assets	0.67 to 1	1.06	0.46	1.00	0.22
Per cent working capital of total assets	—	0.19	—	0.01	—
Per cent net worth of all liabilities	29.75	48.30	27.56	39.65	10.91
Per cent expenses of business	5.8	3.21	9.29	11.67	11.78
Business per employee	$ —	4,198	1,988	1,372	5,021
Business per patron	$ 1,217	1,181	585	686	628

TABLE 3.—RATIO TESTS APPLIED TO OPERATIONS OF TEN CO-OPERATIVE FRUIT COMPANIES IN NOVA SCOTIA FOR THE SEASON 1930-31[1]—*Concluded*

	O	P	Q	R	S	T
Current assets to current liabilities	0.62	1.13	1.39	1.09	0.75	0.75
Worth to debt	0.33	0.84	0.56	0.41	—	0.59
Business to plant value	2.35	3.77	8.65	2.99	5.67	3.21
Net worth to fixed assets	0.46	0.91	1.15	0.94	—	0.67
Per cent working capital of total assets	—	0.06	0.19	0.06	—	—
Per cent net worth of all liabilities	24.88	45.50	35.81	29.30	—	37.00
Per cent expenses of business	13.20	3.41	3.61	9.62	3.77	3.62
Business per employee	$ —	—	5,991	8,118	5,533	6,124
Business per patron	$ 342	812	2,330	1,827	885	2,156

[1] Individual plants are designated by letters K, L, M, etc.

[2] Considering the ratios in the form of a fraction, 1 is to be understood as the denominator in all cases.

of 8.8 cents on the sales dollar for supplies. If the surplus which would accrue from such a working arrangement were put aside in reserve, in one year there would be a fund built up which would reduce the mortgage by one-half and in five years practically the entire present indebtedness would be cleared off. This pre-supposes that the number of companies handling fruit are necessary and it is in the interest of the industry to maintain all of them in operation.

If there is duplication of services and under-capacity volume of business which this analysis and other surveys of the Nova Scotia fruit packing industry seem to indicate, then some of the warehouses may not be essential to the welfare of the industry. A recent investigation into the economic aspects of the apple industry in Nova Scotia points out that there are 25 warehouses on one branch line of 13.6 miles or an average of 1.8 warehouses per mile[3]. The majority of the plants were built in the time of horse drawn vehicles when close proximity to the orchard and packing house were more necessary than to-day. Improved roads and the motor truck have changed the situation. Regional reorganization with consolidation of a number of the low capacity houses would increase the volume per plant and should thereby reduce the cost per unit.

[3] Longley, Willard V. Some economic aspects of the apple industry in Nova Scotia. N.S. Dept. Agr. Bull. 113. 1932.

ECONOMIC LITERATURE

RYE, THE PRODUCTION AND DISTRIBUTION OF COARSE GRAINS, III. Agricultural Branch, Dominion Bureau of Statistics, Department of Trade and Commerce, Ottawa, p. 32.

This publication is the third of a series dealing with statistical and other data relating to Canadian coarse grains, their place in world production and trade.

Rye has never assumed a very important place in cereal production in Canada, reflecting, of course, a limited market in a country where wheat is cultivated on a large scale. In 1933 the area sown was 583,500 acres, which represented 1.3% of the total area sown to the four main cereals for that year. The area devoted to rye has decreased rapidly during the last few years; in 1930 rye acreage reached its highest peak in the past ten years. Prior to the war the acreage was small and relatively stable. Under the stimulus of the war and post-war demand acreage increased from 111,280 acres in 1914 to 2,105,367 acres. Large decreases occurred in 1923 and 1924 but from 1925 to 1930 rye acreage rose steadily, after which time decreases again took place. It is apparent, therefore, that the development of the rye industry in Canada has been marked by radical increases and decreases.

In spite of the increase in wheat production and consumption in the past thirty years, the world still consumes from 1½ to 2 billion bushels of rye annually. The fact that rye is still the chief food of millions of people indicates in a tangible way the merits of the grain as a bread stuff. Rye bread is most generally used in Russia, Germany and Poland where a large part of the world's crop is produced. In Canada the distilling industry provides the largest industrial outlet for surplus rye, small amounts are used for human food products while a considerable proportion is fed or otherwise consumed on farms.

In addition to the information on the production and uses of rye which has been briefly summarized in this short review the report also outlines the world production and trade in rye, Canada's trade, prices of rye in Canada and governmental policies in respect to rye in foreign countries.

KRAEMER, ERICH, and ERDMAN, H. E. History of Co-operation in the Marketing of California Fresh Deciduous Fruits. Bulletin 55, Agricultural Experimental Station, University of California.

The authors of this bulletin have presented a comprehensive review of the development of co-operative marketing of California fresh deciduous fruits. The history of the California deciduous fruit tree industry dates back to the beginning of the settlement of Alta, California, by the Franciscan fathers in 1769. The first real evidence of commercial fruit production, however, did not appear until the days of the Gold Rush in 1849. From this time onward the authors have traced the development of the various organizations which led up to or fostered the co-operative marketing of California fresh deciduous fruit. The earliest movement for collective actions in connection with the sale of fruit was probably the California Fruit Growers' and Dealers' Association which commenced operations in 1869. Later the California Fruit Union was organized and in time it was replaced by the California Fruit Growers' and Shippers' Association. The California Fruit Union created in 1885 provided the first plan for the establishment of a state-wide grower-owned and grower-controlled co-operative marketing system for fresh deciduous fruits. After the first year, it became a grower-dealer organization. Having lost its grower character and having failed to obtain the expected market control, it passed out of existence during the business depression of 1894. In 1901 another state-wide organization called the California Fresh Fruit Exchange (now the California Fruit Exchange) was formed. At present the Exchange co-ordinates the activities of the large majority of the existing co-operative associations for fresh deciduous fruits and has spread its grower connections over the entire state and into Arizona. In collaboration with the California Fruit Growers' Exchange it has also built up an effective sales system and has made

good progress in the development of an export business. To-day approximately 8,000 growers are organized in some 90 local co-operative associations which handle about 11% of the fresh fruits shipped from California, as well as some portion of such commodities sold in the state itself. Most of these organizations are federated with the California Fruit Exchange.

The basic reason for the urge to form co-operative associations throughout the period of sixty-odd years has been low prices to growers. The principal reasons given in explanation for low prices were:—

"(1) High freight and refrigeration charges. (2) High charges by California packers and shippers and by dealers in the East. (3) Dishonest or questionable practices on the part of shippers or on the part of the trade in eastern markets. (4) Lack of aggressiveness on the part of private shippers in developing new markets and correcting evils in transportation or in the eastern markets. (5) Disorganization of markets."

Like many other co-operative movements this one has experienced difficulty in obtaining sufficient grower control which is necessary to overcome disorderly marketing. Because of this "there have been repeated attempts to combine grower and dealer interests so as to include in the organization practically all the fruit."

Kolb, J. H., and Polson, R. A. Trends in Town-Country Relations. Research Bulletin 117, Agricultural Experiment Station, University of Wisconsin and the United States Department of Agriculture Co-operating.

A study of the trends in town-country relationships is important for it shows the necessity of building town and country life together. Such a study was made in Walworth County, Wisconsin, in 1929, and the results are presented in this bulletin. Comparisons are made with a similar study conducted in 1913.

There have been many general changes in Walworth County since 1913. The percentage of native born rose from 75% to 89.5%; the proportion living in the open country and unincorporated centers has been decreasing. The population of incorporated places increased 13.5%. Changes in dairying, the chief industry, have been made to meet the city demand for milk. Villages and small town receiving and processing plants have been replacing small milk stations and creameries.

There have been changes in seven main service areas. Library service areas have increased 158% since 1913; the high school has helped to bring about this change. Milk marketing areas have made a net gain of 64%; this has been due to improved roads, truck transportation and the tendency toward centralized control. The net expansion in high school areas has been 49%. Rural enrolment ranges from 40 to 50% of the total depending on the size of the center. Grocery services have expanded 22%. Chain stores now operate in every center with over 700 population. The old general store has been replaced by a type which carries a few "lines". On the whole there has been no marked increase in the affiliation of country people with the village or town church. Changes in areas for dry goods services have been erratic. Country people have changed their wants more rapidly than the men in the business have changed their methods to satisfy them. Banking service areas show the least net change, though six centers have lost territory while five gained. "Banking service, like grocery and dry goods services, seems to be gravitating toward those men and institutions which are aggressively attempting to give a modern type of service adapted to their country and village or town constituents."

Farm families use on the average four service centers per family, namely, a cross roads, hamlet or very small village center, two villages or small town centers, some city center. Mail order houses are used as well. Country centers are important for restricted merchandise and for primary educational and church services. Towns and villages are increasingly becoming the main centers for many of the services required by farm families. It can now be said that town and country are uniting to form a larger rural community. Farm families go to urban centers for special medical and hospital care, good clothes, and furniture.

NOTES

A statement concerning the Wheat Agreement was made by the Rt. Hon. R. B. Bennett in the House of Commons on March 13, 1934. Legislation has been agreed upon by the four Governments and has been introduced in the legislatures of the provinces of Manitoba, Saskatchewan and Alberta. The proposed legislation empowers the Lieutenant Governor in Council in each of the provinces to set up an emergency Wheat Control Board with power to license and restrict within the province sales and deliveries of wheat. In lieu of separate provincial Boards a joint Board may be set up by the three prairie provinces or by one or more or all of the provinces in conjunction with the Dominion. A province can enact legislation dealing with sales and deliveries within its own borders, but enabling legislation by the Dominion is required to permit control of sales and deliveries outside of a province. With respect to a wheat Board, Parliament will be invited to enact the necessary legislation to enable the Government, in the event of the four governments being of the opinion that the necessity for the same exists, to co-operate with the provinces in establishing a Board with all the necessary authority and powers to deal with any situation which may arise.

The bills to be introduced in the Legislatures of the several provinces will provide also that the Lieutenant Governor in Council shall have power by order-in-council to make all such orders, rules and regulations, and do all such acts and things as in the opinion of the Lieutenant Governor in Council may be necessary and requisite to bring the production of wheat in the province concerned in the year 1934 into proper alignment with the estimated current export demand for the crop season 1934-35 and normal domestic requirements in the same period, having regard to the quota applicable to the Dominion of Canada as provided by Article 2 of the London Wheat Agreement.

"The Agricultural Situation" is the title of a new publication issued jointly by the Department of Agriculture and the Department of Trade and Commerce, Ottawa.

The preparation of such a report was recommended by the National Advisory Committee on Agricultural Services for Canada which appointed a sub-committee composed of Dr. J. F. Booth, Economics Branch, Department of Agriculture; Dr. T. W. Grindley, Agricultural Branch, Dominion Bureau of Statistics, and Dr. J. E. Lattimer, Macdonald College, P.Q., to study the matter further and to make plans to give effect to their recommendation. The sub-committee therefore arranged for a meeting of representatives of the various branches of the Department of Agriculture, the Commercial Intelligence Service, and the Dominion Bureau of Statistics. At this meeting plans for the formation of "commodity committees" to prepare reports on specified products were developed. The reports of these committees were subsequently received by a "committee of the whole" at which representatives of the provinces of Quebec, Ontario, Saskatchewan and British Columbia were present. The reports were finally edited by a small committee and made available early in March.

The purpose of such a report is to assemble and interpret statistical and other information necessary in planning farm production and marketing policies. Such information it is felt will be of value to extension workers, farmers, and others concerned with the problems of agricultural industry.

A report of this nature cannot be expected to cover all commodities or to be as complete in respect to certain products as to others, but it brings to the farmer in a concise manner information which has been compiled by several agencies. It moreover represents the combined viewpoints of those engaged in diverse fields of research, administration and extension work.